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ABSTRACT

The Energy 80 program is designed to enhance students understanding of energy, either through supplements to traditional courses, such as mathematics, science, social studies, or homemaking, or by developing a mini-course or interdisciplinary course in energy. Although written for junior high school students, many of the activities may be used in high school and upper elementary grades. This guide makes use of two parts of the program, the student booklet, "Energy 83," and the three-volume resource book, "Teaching about Energy." The guide is organized according to the sequence of topics presented in the student booklet. These topics include: energy fundamentals; energy flows in nature; energy from nuclear fission; renewable energy sources; energy in the United States; economics and decision-making; and conservation. Provided for each activity associated with these topics is a picture of and reference to the appropriate pages in this student's edition of "Energy 83," materials needed from the resource book, objectives, instructional strategies, major ideas to be developed, and suggested reinforcing and extension activities. Each activity also includes a mini-quiz and set of true-false questions (with answers), background information to help teachers better understand the subject before teaching it, and a list of teacher references and resources. (Author/JN)

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TEACHER'S GUIDE TO THE ENERGY 83 STUDENT BOOKLET

1983
Enterprise for Education, Inc.
Santa Monica, California

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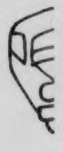
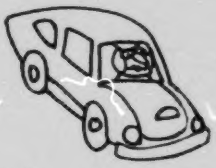

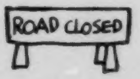

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This edition has been prepared by Dr. George Wilson of the instructional design firm of Moss & Wilson, Santa Monica, CA. It supersedes the first 78 pages of **A Teacher's Guide to the Energy 80 Student Booklet for the 1981-82 School Year,** published in February, 1981.

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ENERGY 83

The **Energy 80** program is planned for teachers who are seeking ways to enhance students' understanding of energy, either through supplements to traditional courses, such as math, science, social studies, or homemaking, or by developing a mini-course or interdisciplinary course in energy.

This guide makes use of two parts of the **Energy 80** program:

the student booklet, **Energy 83**
the resource book, **Teaching about Energy**

The student booklet presents the fundamental information about our supply and use of energy, and also contains some worksheets that encourage students to use the data. **Teaching about Energy** provides additional worksheets, lessons, activities, and readings that reinforce or extend the energy concepts presented in the student book. This resource book is three-hole punched and loosely bound so that it can be taken apart and placed in a three-ring notebook for easy access and duplication. Notice that the book's copyright notice gives you the legal right to copy for your class almost everything in the book.

Examine the student booklet. You will see that it consists of two-page spreads, each of which can stand alone as the focus of a lesson. The resource book, **Teaching about Energy,** follows the same sequence of ideas as the student booklet.

The sequence has been divided into eight parts. Together, they form a comprehensive, interdisciplinary approach to energy education. But any of the parts, or any spread from the book, may be used independently. You can select what meets your program's needs.

The eight parts are:

Energy Fundamentals
Energy Flows in Nature
Fossil Fuels
Energy From Nuclear Fission
Renewable Energy Sources
Energy in the United States
Economics and Decision-Making
Conservation

The problem of supplying energy for the lifestyles we want to enjoy and of using energy in the most efficient way is truly an interdisciplinary one. Whether you teach science or social studies, energy is of such importance that you may wish to consider exposing your students to all aspects of the subject. The booklet provides an easy means of doing so.

Notes

How to Use This Guide to Build an Effective Program

- If you do not plan to use the entire student booklet, select the pages you find appropriate for your program. In the Table of Contents on page 5, find the page number of the Teachers' Guide section describing the first spread you wish to use.

- Turn to the first page of that section. It will look like this:

Topic and subtopic

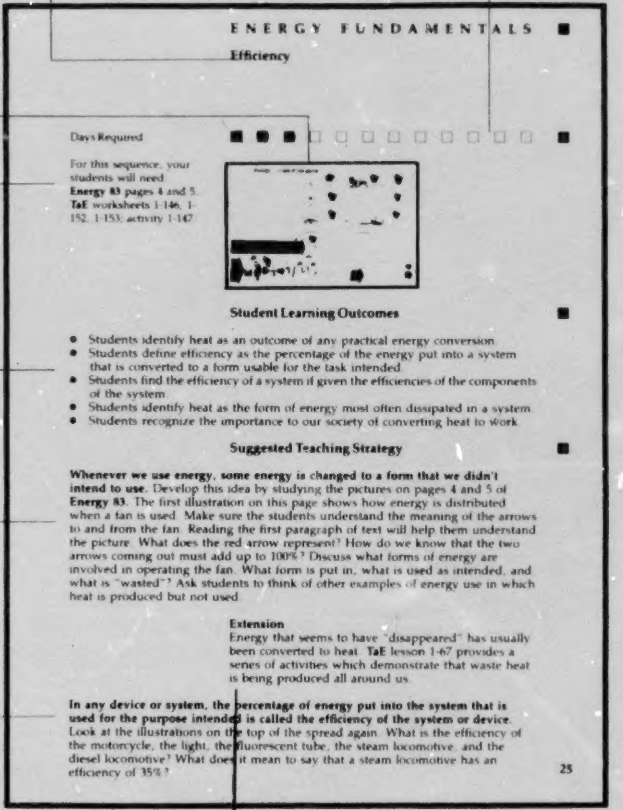
Approximate time needed if you follow the teaching strategy. Each solid box represents one day.

Use this **Energy 83** spread and the related worksheets.

This is a list of materials you will need from the student book and from **Teaching about Energy.**

Student Learning Outcomes.

Suggested Teaching Strategy.



ENERGY FUNDAMENTALS ■

Efficiency

Days Required ■ ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ■

For this sequence, your students will need
Energy 83 pages 4 and 5
TaE worksheets 1-146, 1-152, 1-153; activity 1-147

Student Learning Outcomes ■

- Students identify heat as an outcome of any practical energy conversion
- Students define efficiency as the percentage of the energy put into a system that is converted to a form usable for the task intended
- Students find the efficiency of a system if given the efficiencies of the components of the system
- Students identify heat as the form of energy most often dissipated in a system
- Students recognize the importance to our society of converting heat to work

Suggested Teaching Strategy ■

Whenever we use energy, some energy is changed to a form that we didn't intend to use. Develop this idea by studying the pictures on pages 4 and 5 of **Energy 83**. The first illustration on this page shows how energy is distributed when a fan is used. Make sure the students understand the meaning of the arrows to and from the fan. Reading the first paragraph of text will help them understand the picture. What does the red arrow represent? How do we know that the two arrows coming out must add up to 100%? Discuss what forms of energy are involved in operating the fan. What form is put in, what is used as intended, and what is "wasted"? Ask students to think of other examples of energy use in which heat is produced but not used.

Extension
Energy that seems to have "disappeared" has usually been converted to heat. **TaE** lesson 1-67 provides a series of activities which demonstrate that waste heat is being produced all around us.

In any device or system, the percentage of energy put into the system that is used for the purpose intended is called the efficiency of the system or device. Look at the illustrations on the top of the spread again. What is the efficiency of the motorcycle, the light, the fluorescent tube, the steam locomotive, and the diesel locomotive? What does it mean to say that a steam locomotive has an efficiency of 35%?

25

Main ideas to be developed with each activity are in bold face type.

Indented materials are of two kinds: 1) reinforcing activities requiring materials in addition to the student book; 2) optional extending activities, which are marked **Extensions.**

- Find the student materials you will need in **Teaching about Energy.** Take them out so they will be available when you need them. Store the loose pages in a three-ring binder for future use.

- Follow the teaching sequence. Each sequence contains:

  A picture of the student book spread

  A list of the materials needed

  The objectives to be achieved

  A suggested teaching strategy

A mini-quiz: short answer questions you can use to assess the extent to which the class has mastered the material, or to guide discussions. The page also includes true/false questions; many of these are particularly intended to provoke discussion and require careful thinking rather than just recall.

Background information: material you may want to read to develop your own understanding of the subject prior to teaching it.

A list of references and resources you may use to enrich the lessons.

The Pre-Test and Post-Test test only for material presented in **Energy 83** and the teaching sequences in this **Teacher's Guide.** Material presented only in the Extensions in this Teacher's Guide is not tested for. However, the additional activities do contribute to student mastery of the items tested for.

TOPIC Subtopic	Page number in this guide	Covers these pages in the **Energy 83** booklet
Pre- and Post-Test	8–9	
[Why might we want to study energy? What do we already know about energy?]		
Message from an official	11	inside cover
Record of energy knowledge	11	1
[What is energy, and how does it behave?]		
ENERGY FUNDAMENTALS		
Matter and Energy	13	2–3
Measuring Energy	17	
Measuring Energy Used in the Home	21	
Efficiency	25	4–5
ENERGY FLOWS IN NATURE		
Energy Flow in Wind and Water	31	6–7
Energy in Foods	35	8–9
Origin of Fossil Fuels	41	10–11
Worksheet reviewing energy forms and efficiency	45	12–13
[Where can we get energy?]		
FOSSIL FUELS		
Coal	47	14–15
Oil and Gas Production and Consumption	53	16–17
ENERGY FROM NUCLEAR FISSION	57	18–19
RENEWABLE ENERGY SOURCES	65	20–21
Worksheet for Reviewing Energy Sources	71	22–23

[What is our energy situation now, and how did we get here?]

ENERGY IN THE UNITED STATES

The More We Have, the More We Use 75 24–25
Energy Production and Consumption 81 26–27

Worksheets for the graph spreads

worksheet for pages 24–25 85 28
worksheet for pages 26–27 86 29

[How is scarce useful energy allocated between uses?]

ECONOMICS AND DECISION-MAKING

Investing in Energy 87 30–31
Buying Energy Abroad 95 32–33

[How can we use energy efficiently?]

CONSERVATION

Saving Energy Dollars at Home 99 34–35
Climate and Comfort 103 36–37
The Building Envelope: Infiltration 109 38–39
Insulation 113 40–41
When You're Hot... 117 42–43
Getting into Hot Water 121 44
Home Conservation Review 123 45
Energy and Happiness 127 46–47
Energy Saving at Work 131 48

Notes

Pre-Test

1. In almost any energy change, some energy is "lost" in the form of ________ .
2. An engine for a model airplane burns fuel to turn a propeller. One-third of the energy from the burning fuel causes the turning of the propeller. Two-thirds causes the engine to become hot, and creates a loud noise. What is the efficiency of the engine?
3. In food, energy is stored as molecules such as sugar. Where did this energy come from?
4. What is a British thermal unit, or Btu?
5. Your electric bill indicates the amount of electricity you use, measured in units called ______________________ .
6. What is the source of energy that causes air movements?
7. Which fuel provided the most energy in the United States in 1800?
8. In photosynthesis, water and carbon dioxide combine to form what substance?
9. Plants produce food with energy from the sun. Name one other energy source, and one use of that energy, that is related to our food supply.
10. What chemical element is the principal fuel in most nuclear power reactors?
11. With what material does the process of coal formation begin?
12. Where do all renewable energy sources originate?
13. What conditions are necessary for coal to form?
14. What is the single greatest use for coal in the United States today?
15. Name three atomic particles.
16. What is the biggest single use of energy in American homes?
17. In a nuclear reaction, what part of the atom is split and what event causes it to split?
18. Which source of energy made possible the Industrial Revolution?
19. Name the three main parts of a solar heating system.
20. What is the largest single source of energy for the American economy today?

Post-Test

1. A boy rubs two sticks together and starts a campfire. What forms of energy are involved in this act?

2. In a light bulb, only 2.5% to 4.5% of the electricity used produces light. What happens to the rest of the electrical energy?

3. Green plants use carbon dioxide and water to produce sugar. What energy source drives this reaction?

4. A farmer uses a windmill to pump water. What is the original source of the energy that drives the mill?

5. You get energy out of food by breaking down the food molecules into what two chemicals?

6. What special condition kept the dead plants of the ancient world from rotting before they could change into coal?

7. What chemical element is coal mostly made of?

8. Between 1850 and 1900, America's use of coal grew tremendously. Why didn't our use of coal continue to grow at the same rate in later years?

9. What was the chief commercial use for petroleum between 1860 and 1900?

10. Why does oil tend to become more expensive as we use up more of our oil resources?

11. What is the name of the nuclear reaction in which hydrogen changes to helium?

12. Name two chemical elements that can be used as fuel in a nuclear reactor.

13. In a solar heating system, the collector is usually black. Why?

14. What is the biggest single use of energy in American homes?

15. In the United States, four energy sources provide most of the energy for homes and businesses. Name these four energy sources.

16. What form of transportation consumes the most energy in a year?

17. Why do we import so much oil when we still have large oil and gas reserves in this country?

18.
19. Name three things you might do to conserve energy in your home.
20.

Answers to the Pre-Test

1. Heat
2. 33%
3. Sunlight
4. The quantity of heat needed to raise the temperature of one pound of water one degree Fahrenheit
5. Kilowatt-hours
6. Sunlight
7. Wood (or firewood)
8. Sugar or carbohydrate
9. Petroleum; run a tractor
10. Uranium
11. Plants
12. Sunlight
13. Plant matter deposited in a place where there is not enough oxygen for it to decay, and where it is covered by sediments
14. To generate electricity
15. Neutron, proton, electron. (Some students may know the names of others, such as mesons or neutrinos, and credit should be given for such answers.)
16. Space heating
17. Nucleus; when the nucleus is hit by a slow-moving neutron.
18. Coal
19. a) solar collector, absorber
    b) fluid, water or air
    c) storage tank, storage bin, thermal mass
20. Crude oil

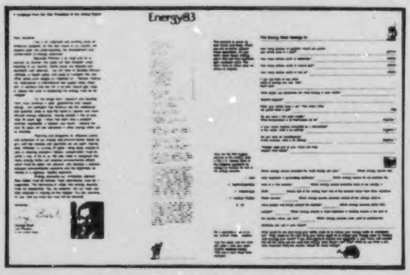
Answers to the Post-Test

1. Motion, light, heat, chemical energy.
2. Heat
3. Sunlight
4. Sunlight
5. Carbon dioxide and water
6. They were submerged in water; lack of oxygen kept them from rotting
7. Carbon
8. Crude oil and natural gas (petroleum) became available
9. Run engines
10. More expensive to get
11. Fusion reaction
12. Uranium, plutonium (Thorium is used in some types of research reactors. Other elements are used in exotic reactors such as those in spacecraft.)
13. Black absorbs more light than other colors
14. Space heating
15. Coal, oil, natural gas, nuclear fission
16. Automobiles
17. Imported oil appears to be cheaper
18. Many potential answers, including:
19. Insulate; caulk, weather strip
20. Obtain more efficient appliances

Message from an Official

Days Required ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ■

For this introduction to the **Energy 83** program, your students will need to read the **inside front cover** of the student book and use **page 1** of the book as a worksheet.



Student Learning Outcomes

- Students name at least one responsible leader who considers energy supply and use to be a matter that requires serious attention.
- Students assess their own knowledge of the energy situation.
- Students prepare a statement they can use to evaluate their progress during the unit.

Suggested Teaching Strategy

Learning about energy is important. Begin to build this sense of importance by asking your students to read the message on the inside front cover of **Energy 83**. Who wrote the message? What are this person's responsibilities? What concerns does this person seem to have about energy? Why?

In some states where **Energy 80** is used, a message from a local leader has also been provided. What region does this person represent? Does this person say that energy use or availability in his or her state is different from that in other states? How is it different? What special challenges or opportunities do these differences provide?

Ask students to name some uses of energy. What are some of the energy sources we use?

Each of us knows a lot about energy, but there are many things we do not know. Ask your students to complete the questions on page 1 of **Energy 83.**

The questions in the top half of the page deal with personal energy consumption. Students need to relate their study of energy to their own lives, but use care in asking students to share such data with the class, as this can embarrass students and violate their parents' right to privacy.

Review students' answers to the questions at the bottom of the page with them. You will find that some knowledge about energy is common knowledge among your students, that the students guess about other facts, and that there are some basic energy facts that the students are not even prepared to guess about.

Discuss the answers; then save the pages so that students can update their answers as they increase their knowledge about energy.

To aid you in guiding student discussion, here are the answers to the last set of questions:

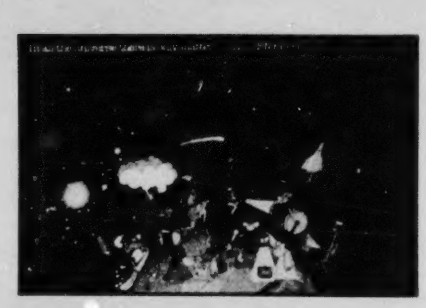
Which energy source provided the most energy last year?
Oil
Which energy source is produced in the greatest quantity in the United States?
Natural Gas
Which energy source provided most of our energy in 1940?
Coal
Which energy source is most heavily imported?
Oil
Which came from sunlight?
Oil, coal, natural gas, hydroelectricity
Which source is most important in heating homes?
Depends on your location*
Which source provides most of the electricity for your home?
Depends on your location*

*Often, a good source of such information is the public affairs department of your local utility company.

Matter and Energy

Days Required ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ■

For this sequence, your
students will need:
Energy 83, pages 2 and 3.
Teaching about Energy
(TaE) worksheet 1-13



Student Learning Outcomes ■

- Students name five different forms of energy.
- Students recognize that we cannot make or destroy energy.
- Students describe a situation in which energy is converted from one form to another.
- Students trace energy conversions related to at least one daily activity.
- Students recognize that energy is lost to our use at each energy conversion.

Suggested Teaching Strategy

Energy occurs in many forms. Heat, light, electricity, chemical energy, and the energy of motion are some of the forms of energy. Look at the pictures on pages 2 and 3 of **Energy 83.** Discuss the forms of energy illustrated on these pages. What forms of energy are being used by the people in the pictures? The brief text on these pages provides a discussion pattern: What kind of energy is each person starting with? What kind of energy is each person trying to use? Your students will easily provide these answers:

Picture	Energy Form at start	Energy Form being sought
motorcyclist	chemical	motion
woman in robe	electricity	heat and motion
race official	chemical	sound (motion)
cyclist	chemical	motion
woman with knife	chemical	motion
Brownie	light	heat
Boy Scout	chemical	heat
Diogenes	chemical	light
man with flashlight	chemical	light

Energy can be changed from one form to another. The students have been discussing energy changes as they analyzed the pictures. Can they think of an energy use in which energy does not change form?

In your discussion you may wish to use **TaE** worksheet 1-13, which provides a grid in which students can indicate tools used to convert one form of energy to another. Students should not be graded on this sheet; rather, their answers should be used as a springboard for discussion.

Extensions

TaE describes a series of activities and demonstrations that can be used to give students concrete experiences with converting energy from one form to another. Each requires a class period.
1-15: students convert electricity to light.
1-19: students convert motion to electricity and electricity to motion.
1-31: teacher changes heat to electricity
1-37: teacher changes light to motion
1-41: students change chemical energy to electrical energy
1-47: students change electrical energy to chemical energy

In each energy conversion, some energy is lost. That is, it is changed to a form that has no planned use in the situation. Ask your students to rub their hands together vigorously for a few seconds. What happens? The students are converting chemical energy in their muscles to energy of motion, but the hands get warm. Energy is "lost" to the system as heat. Now look again at pages 2 and 3. Besides the beginning form and the desired form of energy in each situation, what other forms of energy are involved? Students will quickly name heat as an outcome of almost all energy conversions. Sound and light are also sometimes evident but not always desired. Discuss whether all the energy put out is equal to all the energy put into a system.

Mini-Quiz

1. Name one kind of stored energy.
2. Describe a way of changing chemical energy into light.
3. What form of energy goes into an electric motor? What form comes out?
4. What form of energy do we start with when we run an automobile?
5. What form of energy do you run on?
6. What form of energy is present in natural gas?
7. What form of energy does a speeding bullet have?
8. Name a way of changing chemical energy to heat.
9. In friction, what form of energy is converted to what?
10. Name a device that changes motion to electricity.

True or False?

1. Energy is destroyed when you blow out a candle.
2. As a candle burns, energy is destroyed.
3. Someday, scientists will succeed in building an engine that will move cars and not need any fuel or other source of energy.
4. In most energy conversions, part of the energy is converted to heat.
5. Since energy cannot be destroyed, there is no need to conserve it.
6. If a machine does not convert all the energy we put into it into a form we plan to use, we shouldn't use that machine.
7. One way to improve our use of energy is to find ways to use the heat given off in energy conversions.
8. Chemical energy can be converted to light.
9. People have invented devices which make it easy to convert electrical energy to many other forms of energy.
10. Motion can be changed to heat.

Answers

1. Chemical energy, food energy—any form of energy except heat, light, or electricity.
2. Combustion, battery-powered flashlight, light produced by fireflies...
3. Electrical energy in, energy of motion out (plus heat and sound).
4. Chemical
5. Chemical
6. Chemical
7. Energy of motion, or kinetic energy.
8. Combustion
9. Motion to heat
10. Electrical generator

True or False?

1. False
2. False
3. False
4. True
5. False
6. False
7. True
8. True
9. True
10. True

Background Information

Forms of Energy

It is important for students to realize that energy takes different forms and to be able to label some common ones. But the list of forms of energy used in this sequence is just a convenience, and is arbitrary. Many other forms of energy could be named, such as the elastic energy in a rubber band, the surface energy of solids and liquids, the binding energy of the nucleus, and so on.

Measuring Energy

Days Required ■ ■ □ □ □ □ □ □ □ □ □ □

For this sequence, your students will need:
TaE worksheets 1-63, 1-65, 1-86.
TaE activity pages 1-54.
TaE overhead 1-85.

Student Learning Outcomes

- Students measure a quantity of heat.
- Students use measurements of energy to track a flow of energy.
- Students define calorie, Btu, Calorie (kilocalorie), and kilowatt-hour.

Suggested Teaching Strategy

Energy can be measured. Learning more about energy units is best done by actually taking measurements, rather than by listening to someone tell about it. Heat is the easiest form of energy for students at this grade level to measure. Another reason that makes it worthwhile spending the time to teach how to do so is that the method can later be applied in studying other topics like efficiency, food energy, and solar energy.

Most students are familiar with the word "calories." Follow **TaE** lesson 1-51 to teach students to read a thermometer and to learn to calculate the number of calories of heat transferred to a known volume of water when it changes temperature. Student directions for this activity and directions for computing calories make up **TaE** worksheet 1-54. Distinguish between the calorie and the kilocalorie, which is the Calorie (capital C) of the Calorie-counting tables used by dieters.

Many teachers have their own lessons for teaching about energy units. Use your lessons, or try the activities described in **TaE**:

In the United States, energy use is often measured in British thermal units. The English, or customary, measurement for heat is the British thermal unit, a unit equivalent to about 252 calories. Since the Btu is the energy unit used in government energy statistics, gas bills, and on many appliance labels, students need to learn what it means. Having learned the meaning of calorie through activities dealing with heat flow, students should easily understand the unit of heat measurement in the English system. **TaE** lesson 1-63 helps students develop a definition of a Btu.

Extension
Heat can be measured in Btu's or calories. Once the students have defined both units, **TaE** activity 1-65 helps students relate Btu's to calories.

Electrical energy can be measured. Ask students to read the information on some electric light bulbs of various sizes. What is the name of the unit used? Which bulbs give the most light? Which have the higher wattages? Roughly define a kilowatt in terms of a number of light bulbs.

Which will use the most electricity, burning one of the large bulbs for a hour or burning one of the small bulbs for an hour? Watts are a measure of power, not energy. They tell us the rate at the device can convert energy from one form to another. To measure how much energy is consumed, we must know how long that amount of power was used. Define kilowatt-hour in terms of leaving a number of light bulbs of a given type burning for an hour.

Electrical appliances often indicate electrical use in amperes (amps) and volts. Use your science text to define these units if you feel it is appropriate. It is sufficient for this study to define a watt as a measure of electrical power (1 joule of energy per second).

Learning about electrical units helps us understand the tools we use. Students can readily see the need for understanding the electrical units if they try to interpret information on appliance labels. Samples of such labels are provided in **TaE** 1-85, which can be used to create an overhead transparency.

To reinforce the idea that watts are units that indicate electrical power, ask your students to complete **TaE** worksheet 1-86 as a homework assignment. The assignment asks students to find information on appliance labels at home.

Mini-Quiz

1. Name the unit of heat energy in the English, or customary, system.
2. Name the unit of heat energy in the metric system.
3. Watts, amperes, and volts are units that apply to what form of energy?
4. Suppose heat flowed between two bodies of water. What two things would you need to measure in order to know how much heat was transferred?
5. When all the world is going metric, why should we learn about Btu's?
6. What units of measure are marked on an electric light bulb?
7. What energy units would you expect to find if you read a gas water heater label?
8. About how many calories are equal to one Btu?
9. When we talk about energy in foods, what units of energy do we use?
10. What is the difference between a calorie and a Calorie (capital C)?

True or False?

1. A Btu is the amount of heat needed to raise the temperature of one quart of water one degree Fahrenheit.
2. Btu's and calories measure different forms of energy.
3. There is no way to change calorie measurements into Btu measurements.
4. Since most of the world is measuring in metric units, there is no need to learn about the Btu.
5. We can convert a measurement in Btu's to an equivalent measurement in kilowatt-hours.
6. Two electrical appliances that both work on 115-volt electricity will use the same amount of energy.
7. A heater that runs on 115 volts will give off 115 Btu per hour.
8. A watt and a volt are measures of the same thing.
9. A 4-watt electric clock might use more energy during a year than a 1000-watt popcorn popper.
10. A 1200-watt hair dryer uses three times as much energy while it is running as a 400-watt television set does.

Answers

1. Btu
2. A calorie
3. Electrical
4. Mass and temperature
5. Because much of our measurement of energy is in Btu's
6. Watt, amp, volt
7. Btu
8. About 252
9. Calories (capital C)
10. One Calorie equals 1000 calories

True or False?

1. False
2. False
3. False
4. False
5. True
6. False
7. False
8. False
9. True (In a year, the clock running continuously will use more than 35 kilowatt-hours. If the popper were used for 15 minutes once a week, only 13 kWh would be used per year.)
10. True

Background Information

One calorie is the amount of heat required to raise the temperature of one gram of water one degree Celsius.

It is helpful that many students already know the word calorie from its use in nutrition. However, students can also be confused by this popular usage, because the "calories" spoken of by dieters are kilocalories, 1000 "small" calories. To distinguish them from calories, some people spell them with a capital C. It is much clearer to always use the prefix kilo-.

A Btu is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. One Btu is approximately 252 calories.

One watt-hour is about 860.4 calories or 3.4 Btu's.

Measuring Energy Used in the Home

Days Required ■ ■ ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ■

For this sequence, your students will need: **TaE** worksheets 1-97 through 1-101, 1-109 through 1-113

Student Learning Outcomes ■

- Students will read an electric meter.
- Students will read a gas meter.
- Students will interpret an electric bill.
- Students will interpret a gas bill.
- Students will recognize that more energy is used at certain times of day or year than at others.

Suggested Teaching Strategies ■

Knowing how to read an electric meter can help us learn how to use energy wisely. Being able to read a meter—gas or electric—enables us to relate the dollars we pay to the utility to the wattages of the appliances we use, and the ways we use them. It encourages us to use energy wisely by providing immediate feedback on the effect of the conservation measures we undertake. Teach your students to read an electric meter.

Follow **TaE** lesson 1-95. The lesson shows how to use **TaE** worksheets 1-97 through 1-101 to help the students develop skill in meter reading.

Recognizing times of peak energy use and of low energy use is a first step in one way of using energy more efficiently, since the ways utilities generate peak-load electricity are less efficient than the means they use to generate the amount of electricity used at all hours of the day and night. As a homework task, students can now begin to keep records of energy use to see when most electrical energy is used. **TaE** worksheets 1-102 and 1-103 are record-keeping forms for tracking electric energy use through one day and one week.

Energy costs. We pay for electrical energy according to the number of kilowatt-hours of electricity we use. While students are gathering information about when their families use the most electricity, help them learn to read a utility bill. Ask the students to bring in samples of the electric bills for their own homes. Bring in your own bill as a sample. Discuss what the information on the local utility bill means.

An example of a bill is included in **TaE**, but you should use a sample of your local bills. Your local bills may differ greatly from the sample in **TaE** 1-108.

Knowing how to read a gas meter can help us learn how to use energy wisely. Use **TaE** worksheets 1-110 and 1-111 to help your students learn to read a gas meter. Note that the gas meter does not measure directly in energy units, but indicates the number of cubic feet of gas that has flowed through the meter.

Gas bills indicate the amount of energy used in two ways. Usually, the bill indicates the number of cubic feet of gas used, but translates this information into energy units. (Often these units are "therms." One therm equals 100,000 Btu.) Ask your students to bring in samples of their home gas bills. Bring in your own to discuss. Work with the students to understand the items on the bill.

Again a sample bill has been provided (**TaE** 1-112) but it may differ greatly from your local bill.

Knowing when we use energy and for what purpose can help us use it more wisely. It is important that students keep an energy diary for at least one day. This diary may be kept on the worksheets provided (**TaE** 1-103, 1-117 or on the students' own forms. Examine and discuss the electric diaries the students have kept (these usually show more obvious patterns than the gas diaries do). What hour of the day shows the most energy use? What day of the week? What causes these peaks? Recently, utility companies have placed advertisements advising us to "give your appliances the afternoon off." Do the diaries suggest any reason for this ad? How would it benefit consumers if energy use were evened out over the entire day, week, or year?

Save the diaries. You will find them useful again when your students begin to study energy conservation.

Mini-Quiz

1. In what units does your electric meter indicate the amount of electricity you use?
2. In what units is energy from gas indicated on your gas bill?
3. What other units are listed on the gas bill?
4. A 100-watt light bulb burns for 10 hours during one month. How many kilowatt- hours of electricity will be charged to that one light bulb?
5. How many Btu's are equivalent to one therm?
6. Which of these bits of information might you expect to find on an electric company bill: (a) kilowatt-hours used, (b) appliances that used most electricity, (c) ending meter reading, (d) beginning meter reading, (e) therms used.
7. Which of these bits of information might you expect to find on a gas bill: (a) amount of gas used for cooking, (b) beginning meter reading, (c) ending meter reading, (d) kilowatt-hours used, (e) therms used, (f) beginning and ending billing dates.
8. Why is it important to think about when we use our electrical appliances?
9. If your utility bill keeps going up despite your efforts to save energy, are your efforts to conserve saving you any money? Explain.
10. How can you tell whether the hand on the dial of an electric meter has reached a number yet?

True or False?

1. It is possible to express quantities of energy in either kilowatt-hours or calories.
2. The typical American family uses about the same amount of energy in each month of the year.
3. Utilities would like us to balance our use of energy during a day or a week so that they can use their equipment more efficiently.
4. An electric bill tells how many kilowatt-hours of electricity you purchased.
5. If the meter face is labelled "x 10," two zeros should be added to the reading.
6. Gas meters and electric meters measure in the same units.
7. Some of the hands on an electric meter revolve in one direction; some in the opposite direction.
8. The higher the wattage of an appliance, the more electricity it consumes while running.
9. Most families use the same amount of energy during each hour of the day.
10. People use the greatest amount of electricity at 3 A.M.

Answers

1. Kilowatt-hours
2. Probably therms, check the local gas bill
3. Cubic feet of gas used
4. One kilowatt-hour
5. 100,000
6. a,c,d
7. b,c,e,f
8. The more the load is balanced throughout the day, the better the use of the utility's equipment.
9. The bill would be even higher if you didn't practice conservation.
10. By checking whether the hand on the dial to the right has passed zero yet

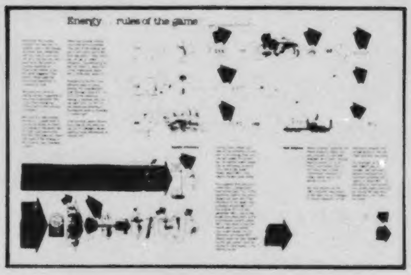
True or False?

1. True
2. False
3. True
4. True
5. False
6. False
7. True
8. True
9. False
10. False

Efficiency

Days Required ■ ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need:
Energy 83 pages 4 and 5.
TaE worksheets 1-146, 1-152, 1-153; activity 1-147.



Student Learning Outcomes

- Students identify heat as an outcome of any practical energy conversion.
- Students define efficiency as the percentage of the energy put into a system that is converted to a form usable for the task intended.
- Students find the efficiency of a system if given the efficiencies of the components of the system.
- Students identify heat as the form of energy most often dissipated in a system.
- Students recognize the importance to our society of converting heat to work.

Suggested Teaching Strategy

Whenever we use energy, some energy is changed to a form that we didn't intend to use. Develop this idea by studying the pictures on pages 4 and 5 of **Energy 83.** The first illustration on this page shows how energy is distributed when a fan is used. Make sure the students understand the meaning of the arrows to and from the fan. Reading the first paragraph of text will help them understand the picture. What does the red arrow represent? How do we know that the two arrows coming out must add up to 100%? Discuss what forms of energy are involved in operating the fan. What form is put in, what is used as intended, and what is "wasted"? Ask students to think of other examples of energy use in which heat is produced but not used.

Extension
Energy that seems to have "disappeared" has usually been converted to heat. **TaE** lesson 1-67 provides a series of activities which demonstrate that waste heat is being produced all around us.

In any device or system, the percentage of energy put into the system that is used for the purpose intended is called the efficiency of the system or device. Look at the illustrations on the top of the spread again. What is the efficiency of the motorcycle, the light, the fluorescent tube, the steam locomotive, and the diesel locomotive? What does it mean to say that a steam locomotive has an efficiency of 35%?

If your students have learned to measure calories or Btu, and understand conversion factors, they can measure experimentally the efficiency of an electric hot plate—pot system. **TaE** lesson 1-141 describes such an investigation. Activity 1-147 guides students through the procedure; worksheet 1-146 organizes data gathering and computation. This is a key activity that is highly recommended.

Efficiency has dollar implications. To extend the students' understanding of efficiency to the "real world," **TaE** lesson 1-149 provides forms for conducting a lighting energy audit, which demonstrates to students how differences in efficiency (incandescent vs fluorescent lighting) can have an important dollars and cents effect.

In considering efficiency, we need to look at the efficiency of the system, not just one particular component. The picture at the bottom of page 4 illustrates the steps through which energy goes in two systems, both of which end with water heating in a home heater. Discuss the meanings of the arrows and the significance of the size of the arrows. Looking only at the heaters, which seems to consume less of the energy source, the gas heater or the electric heater? The electric heater. Which looks better after looking at the whole system? The gas heater. At each step, some energy is given off as heat. So, at the next step there is less available energy to start with. The effect multiplies. To find the efficiency of a system, multiply the efficiencies of each component.

Discussion of the hot plate experiment described in **TaE** 1-141 provides an initial exposure to systems. Additional work in **TaE** 1-155 helps students learn to think in terms of system efficiencies, and teaches how to calculate the efficiency of a system.

Extension

Energy Quality and Second-Law Efficiency

The idea of efficiency that we have been developing is fundamental, but in one respect it is inadequate. It treats a quantity of energy in the form of heat exactly the same as a quantity of energy in the form of work.

We can change 100% of a quantity of work to heat (through friction, for example), but the reverse is not true. To convert heat to work, we usually use a heat engine, like a steam engine, gasoline engine, or turbine. Heat engines have maximum theoretical efficiencies of less than 50%; the higher the temperature of the heat source in the engine, the more of the heat that can be converted to work. So a source of high-temperature heat is high in available work, but very little of the energy in a low-temperature source, like room temperature air, can be converted to work by a heat engine. Such low-temperature heat sources are low in available work.

People value work a lot more than they do an equivalent amount of heat. So energy sources have different qualities. A high-quality energy source is one high in available work.

Sometimes we have a choice of doing a task with either by work or heat. For example, we can heat a house by burning gas in a furnace or by using electricity in a motor to drive a heat pump. In such situations it would be helpful to be able to compare how much available work each way of doing the job would consume. To do this, physicists have developed a measurement called second-law efficiency.

TaE presents a series of lessons (1-161 to 1-182) that develop these concepts.

Notes

Mini-Quiz

1. Whenever energy is converted from one form to another, part of the energy is converted to what form of energy?
2. To calculate ________, we divide the amount of useful energy we get out of an energy conversion by the amount of energy we put in.
3. Which is more efficient, an incandescent light bulb or a fluorescent light bulb?
4. Two electric lights use the same amount of electricity, but light A gives more light than light B does. Which light is more efficient?
5. Two electric fans produce exactly the same air movement. Fan B uses less electricity than Fan A. Which fan is more efficient?
6. The people who design turbines are making a great effort to find new materials for the turbine blades. They are using experimental materials like ceramics because metals lose their strength at the temperatures at which engineers would like the turbines to operate. Why are engineers trying to make engines that can run at higher temperatures?
7. What do we call a machine that changes heat to work?
8. Name two different kinds of heat engines.
9. If energy flows through a connected series of different machines, the amount of useful energy we get from the last machine, divided by the amount of energy we put into the first machine, is called the ____________.
10. Describe the heat flow in a gasoline engine.

True or False?

1. Diesel locomotives are not as efficient as the steam locomotives were.
2. A steam turbine is a kind of heat engine.
3. An automobile converts about 80% of the energy in the gasoline into forward motion.
4. Photosynthesis is a very efficient process compared to an electrical power plant.
5. Any machine with an efficiency of less than 50% is no good.
6. The more powerful an engine is, the more efficient it is.
7. For many energy conversion processes, there is a maximum possible efficiency that cannot be exceeded.
8. The best heat engines are 100% efficient.
9. One way of saving energy is to find more efficient ways of doing things.
10. The efficiency of a system cannot be any greater than the efficiency of the least efficient part of the system.

Answers

1. Heat
2. Efficiency
3. Fluorescent
4. Light A
5. Fan B
6. To increase the efficiency of the engines
7. A heat engine
8. Steam engines, gas turbines, internal combustion engines. . .
9. System efficiency
10. Heat flows from the combustion chamber to the atmosphere.

True or False?

1. False
2. True
3. False
4. False
5. False
6. False
7. True
8. False
9. True
10. True

Background Information

When they have completed this sequence, students should be aware of the meaning of **efficiency**. They should also be wary of making decisions about efficiency solely on the basis of the efficiency of a single component of a system.

For example, students read that the efficiency of a gas water heater is 46% and that that of an electric water heating system is 79%. It looks as though every home owner should install an electric water heating system. But there are other factors to consider.

First, what source of energy was used to generate the electricity? In the student book example, the electricity for the electric heater is being generated by burning natural gas. But only about 15% of the electricity used in the United States is generated from burning gas. Where electricity is generated in hydroelectric plants, it may be more sensible to use electricity for water heating since the energy source is renewable, and gas would be saved for other uses such as high-temperature heating. Similarly, nuclear fission can only be used for home water heating when it is distributed in the form of electricity. If it is desirable to save gas by substituting nuclear energy where possible, then using electricity to heat water for the home would make sense.

Secondly, how is the electricity used? In the example, electricity is converted to heat the way it is in an electric stove: by running electricity through a resistance element. Most electric water heaters work this way. It is not the most efficient way of heating water with electricity. It would be far better to take advantage of the fact that electricity can be easily used to perform work. An electric motor running a heat pump could deliver an amount of heat (taken from groundwater or the air) far greater than the heat equivalent of the electricity consumed. Substituting such an electric water heater for the electric heater shown in the example would produce a system that would have a higher system efficiency than the gas water heater system depicted has. A similar system preheats water using the heat exhausted by air conditioners and again, the heat is made available by the work done by an electric motor. Both heat-pump water heaters and air-conditioner water heaters are practical systems presently in use. There are also more efficient gas heaters.

Lastly, what is required to get the energy to the water heater? If a mile of gas line would have to be laid for a home to use a gas heater, the energy savings would never compensate for the energy used to make and install the pipe.

How can a person decide such questions as which is best in a particular situation, the gas water heater or the electric water heater? Though not infallible, cost is a pretty good guide. The method with the lowest lifetime cost is likely to be the one that uses the least energy. Deciding on the basis of cost also has the advantage of taking into account indirect energy consumption, for example the energy used to manufacture and deliver the heaters.

Resources

Energy and Order, by Mark Dewitt and Paul Terry, presents thermodynamics in a teachable fashion (San Francisco, Friends of the Earth, 1976).

Notes

ENERGY FLOWS IN NATURE

Energy Flows in Wind and Water Cycles

Days Required ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need:
Energy 83 pages 6 and 7.
TaE activity pages 2-14

Student Learning Outcomes

- Students describe the energy conversions in the water cycle in nature and in some wind patterns.
- By tracing energy flows in the water cycle and in air circulation, students demonstrate an awareness that energy for these processes comes from the sun.
- Students recognize that the earth is a heat engine and trace flows of energy from hotter places to cooler ones.
- Students illustrate the great amount and diffuseness of solar energy using a natural process powered by sunlight as an example.

Suggested Teaching Strategy

Almost all the energy we use comes from the sun. Begin to develop this idea by studying the pictures and the reading on page 6 of **Energy 83.** Begin with the sun. In what form does the sun release energy? What happens to this energy when it strikes the earth? Why does the picture show arrows rising from the earth? What happens to the heated air? To what form of energy is the heat in the air converted? Why does it cool as it rises?

A simple demonstration can show that moisture can be carried in the air, and that heating promotes evaporation and cooling condensation. Put a small amount of water in a large jar. Seal the jar and mark the water level. Put the jar in the sun for an hour or so. Mark the water level again and note that it has dropped. Then put the jar into a refrigerator or other cool place. In a few minutes note the water level again and examine the jar for signs of water elsewhere. Discuss where the water that disappeared went, and where the water observed at the end of the demonstration came from. What energy changes made the water evaporate and condense? What happens when clouds form? What happens to the heat in the clouds when they form as shown on page 6?

The earth is a heat engine. From the study of efficiency, students learned that a heat engine converts heat into work or motion and that this is done as heat flows from a hot place to a cool one. Trace this path in the cycles of air and water on pages 6 and 7. Where are the hot places? What energy conversions take place?

The circulation of air comes in part because of uneven heating of the air near the earth's surface. It is possible to show that some colors absorb radiant energy more readily than others by putting black and white papers in the sun and placing thermometers on them. In a short time, the thermometer on the black paper will record a higher temperature than the one on the white paper.

Extension
That radiant energy can lead to air movements is developed in a series of demonstrations and student activities described in **TaE** lesson 2-7. Activity 2-10 is a student activity in which students construct a wind box and study wind circulation resulting from exposure to a lamp. To make the air circulation clearly visible, you may need to hold a smoldering punk near the tops of the tubes in the wind box.

Extension
TaE lesson 2-11 is a similar investigation of evaporation, circulation, and energy flow in a water cycle. The final demonstration creates a miniature water cycle in a gallon jar.

Either the two lessons outlined in **Teaching about Energy** or your own teaching strategies about wind and water cycles should end once the students are able to think of these cycles in terms of energy flow.

We get a large amount of energy from the sun but it is spread out over a large area. Look again at pages 6 and 7. The reading begins with a very large number that indicates the rate at which the sun is pouring energy into space. The amount reaching the earth at noon is said to be about one horsepower per square yard. While this measure depends on the latitude, the time of year, the weather, and even the slope of the ground, it will serve as a point on which to build a discussion about the solar energy that might be available to us. The area of the United States is 3,631,407 square miles. Each square mile is 3,097,600 square yards. Trying to calculate the amount of energy that reaches this surface from the sun each hour (assuming that it was cloudless noon everywhere, which of course is impossible) will give students an idea of the enormous amount of energy radiating from the sun. The Background Information for this sequence provides some information about how much of this energy reaches the earth and how.

Not all of the sun's energy can be converted into energy forms we can use to power our society. Ask your students to help you construct an energy chart showing the flow of energy from the sun. It can be as complex as you and your students wish to make it.

Extension
TaE 2-17 through 2-20 provide a series of diagrams of the flow of radiation from the sun to the earth's atmosphere and surface, and from the earth into space. The charts emphasize how little of the sunlight is used by photosynthesis. If you wish, these can be made into overhead transparencies.

Mini-Quiz

1. About how many watts of sunlight fall on a square yard at noon?
2. What is the name of the process by which plants store light energy as food?
3. At the equator, would you expect air to be rising or falling?
4. It is too bright in my room. I pull dark shades over the window. What form of energy is the light converted to?
5. What form of energy is present in wind?
6. Before 1800, what source provided the energy for travel between Europe and America?
7. As a wet towel dries, what happens to the water?
8. What is the name of the process by which water vapor becomes liquid water again?
9. A farmer is getting electrical energy from his wind-powered generator. Trace the flow of energy back as far as you can.
10. The energy animals use to move comes from their food. Before it was food, what kind of energy was it?

True or False?

1. The sun will not go out for billions of years.
2. Some objects do not absorb any light at all.
3. In a few million more years, all the rain will have fallen into the oceans and there will be no more rain.
4. The temperature of the ocean's surface changes more slowly than the temperature of the land's surface, when the amount of energy reaching them from the sun changes.
5. Almost all of the sun's energy that reaches the earth is captured by green plants.
6. If an object on earth is not green, it cannot capture the sun's energy.
7. The energy of the wind began as sunlight.
8. Compared to the air over the North and South Poles, air over the equator is falling.
9. The process by which water disappears from an open dish is called condensation.
10. Other things being equal, warm water will evaporate more rapidly than cold water.

Answers

1. 500
2. Photosynthesis
3. Rising
4. Heat
5. Energy of motion
6. Wind
7. It turns to water vapor.
8. Condensation
9. Sunlight
10. Light

True or False?

1. True
2. False
3. False
4. True
5. False
6. False
7. True
8. False
9. False
10. True

Background Information

The earth is so small and so far from the sun that only about a billionth of the energy the sun radiates into space reaches the earth's atmosphere.

By far the greatest part of the solar energy that reaches the earth's surface is used to evaporate water. This energy is released again when the water condenses, so the energy in violent storms is enormous. In a single day, a moderate-sized hurricane releases about the same amount of energy as was used in all of the U.S. economy in 1970.

Wind

Uneven heating of the earth's surface causes convection currents called winds. The air rises over warm areas and sinks over cold. Heat energy is changed to energy of motion as the air moves upward, resulting in colder areas high in the atmosphere. But the cold air contracts, making the mass per unit of volume greater, and the air descends. So, a cycle of air movement is created.

The Water Cycle Concentrates Solar Energy

The water cycle concentrates the diffuse energy of the sun. Energy from the sun is present in the energy of motion of every falling raindrop. As the water collects in rivulets, streams, and rivers above sea level, the energy is concentrated. It becomes practical for people to exploit it with mills and hydroelectric plants.

Photosynthesis Also Cycles Materials

Like wind and water, photosynthesis is part of a cycle. Energy is captured when large molecules are built from atoms of carbon, oxygen, hydrogen and energy is released when these large molecules break down. The atoms can then be used over and over again. Every 300 years, an amount of carbon equal to the total amount in all living things passes through the cycle. The oxygen is recycled every 2,000 years.

ENERGY FLOWS IN NATURE

Energy in Foods

Days Required ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your
students will need:
Energy 83 pages 8 and 9.
TaE worksheets 2-46, 2-52,
2-53.
TaE activities 2-47, 2-48.

Student Learning Outcomes

- Students name the materials involved in photosynthesis.
- Students identify the sun as the source of energy that is stored by plants through the process of photosynthesis.
- Students use simple equations for photosynthesis and for respiration to demonstrate that these reactions form a cycle in which oxygen and carbon dioxide are constantly exchanged.
- Students describe a food chain in which they are involved and can trace the energy in the chain to the sun.
- Students describe an activity other than photosynthesis that is part of the United States food system and identify some of the energy sources used in the activity.

Suggested Teaching Strategy

Green plants use energy from the sun to change carbon dioxide and water into sugar. The picture on page 8 of **Energy 83** provides a simple equation for photosynthesis. This equation says that one molecule of CO2 and one of water yield part of a molecule of sugar. Count the atoms of oxygen, carbon dioxide, and hydrogen to see that nothing is lost. What is the energy source for the reaction? What substances are produced?

Extension
Lesson **TaE** 2-21 describes an activity in which students detect oxygen produced during photosynthesis (worksheet 2-25).

Extension
The green pigment chlorophyll is the catalyst in photosynthesis. TaE 2-21 introduces chromatography, a method of demonstrating that the same pigment is present in plants that are otherwise very different.

Extension
Food energy is often stored in the form of starch. TaE 2-25 describes how iodine can be used to detect starch.

Living things get their energy from carbohydrates produced by photosynthesis. On page 9 an equation is shown for respiration. Here oxygen is combined with the sugar to yield carbon dioxide, water, and energy. The end results are the same as we get when we burn foods. Read pages 8 and 9 for an understanding of the cycle.

Extension
Detecting Carbon Dioxide from Respiration
TaE lesson 2-36 suggests an investigation of seed respiration in which students detect carbon dioxide released by germinating seeds. Lesson 2-33 describes an activity (**TaE** worksheet 2-41) in which students determine whether their breath contains more carbon dioxide after exercising.

Extension
We can measure the potential energy in foods by burning the food and measuring the heat produced. **TaE** activity 2-47 gives directions for constructing a simple calorimeter and using it to measure the heat derived from burning food. Worksheet 2-46 leads the students through the calculations needed to determine the number of calories of heat given off by the burning food.

Ask your students to name some of the foods they have eaten that day. Some of them may wish to use the calorimeter to measure heat output from some foods in their own diets. Many foods can be burned in the calorimeter if they are first dried. Some may need a little help to start the burning. For example, a sugar cube ignites readily if it is first rolled in ash. Considerations of the kilocalories (Calories) in foods gives your students an opportunity to discuss diets and their Calorie content.

We depend on green plants for the food we eat. This is easily demonstrated by taking one food a student has eaten and tracing that food through a food chain. Food chains can be demonstrated by involving everyone in the class in a role-playing activity. Assign each student a role as some kind of plant or animal. Choose a student-animal and give that student a ball of twine. Ask the student to keep the end of the string and pass the ball to an animal or plant that might be eaten by the animal the student represents. When the string reaches a plant, the student-plant will be unable to pass it on. Cut the string and start the ball again at another animal, without recovering the string that has been unwound. Students will soon see that all chains involve plants very early in the chain, and that chains are interwoven so that the energy situation in living things is really represented more accurately by a web.

TaE worksheet 2-52 asks students to think about all the living things that are involved in some of the foods they eat.

Extension
Reading **TaE** 2-49 provides an example of a scientist's investigation of energy flow, using methods easily understood by students.

Prepare for the study of energy uses in our food system by asking students to complete **TaE** worksheet 2-53 as a homework assignment.

Our agricultural and food distribution system has many energy inputs besides sunlight. To discuss energy in relation to foods we need to consider all the elements of the food producing/distributing system. Use the analysis of food which students completed on the worksheet or discuss the pictures on pages 8 and 9 of **Energy 83** to develop the idea that there are many ingredients in the foods we eat and that they get to us through a complex processing and distributing system. For example, what is in the hamburger pictured on page 9? Where might the original ingredients have been grown? What happened to them on the way to becoming a hamburger? How does a hamburger get to your home or restaurant? In each step of the process of preparing and making the hamburger available, what energy was used? What was the source of the energy?

Notes

Mini-Quiz

1. Name the three chemical elements that are recycled in the photosynthesis-respiration cycle.

2. Sugars and starches are made of carbon, hydrogen, and oxygen. What name is given to this kind of compound?

3. What form of energy goes into the energy conversion we call photosynthesis?

4. As a result of using food energy, we breathe out a waste gas. What is the name of this gas?

5. Plants give off a gas as a product of photosynthesis. What gas is given off?

6. As energy is passed along a food chain, approximately what percent of the energy is lost at each step of the chain?

7. What is the name of the gas that plants take in as raw material for photosynthesis?

8. What units do we use to measure food energy?

9. What are the biggest sources of energy used in the food system of the United States?

10. When you eat a 1000-Calorie meal, about how many Calories of energy (other than food energy) were needed to put that meal on your plate?

True or False?

1. Each year, carbon is used up in photosynthesis, so eventually the world will run out of carbon.

2. If there were no plants, only the meat-eating animals could survive.

3. The energy you use to ride a bike came from a star.

4. There is no limit to the amount of food energy farmers can obtain from an acre of land, if they can use as much water and fertilizer as they want.

5. People are at the very bottom of the food chain.

6. Plants do not break down carbohydrate molecules to get energy.

7. The harder you work, the more carbon dioxide you will exhale.

8. A person who lies perfectly still is not using any food energy.

9. Starch is a carbohydrate.

10. The food processing industry relies mostly on coal.

Answers

1. Carbon, hydrogen, oxygen
2. Carbohydrates
3. Light
4. Carbon dioxide
5. Oxygen
6. 90%
7. Carbon dioxide
8. Calories or kilocalories
9. The sun and oil (natural gas is third)
10. 100,000 Calories

True or False?

1. False
2. False
3. True
4. False
5. False
6. False. They get their energy from respiration just as animals do.
7. True
8. False
9. True
10. False

Background Information
The text emphasizes photosynthesis in leaves, but non-leafy plants are also important. Of the estimated 200 billion tons of carbon bound into living things each year through photosynthesis, only 20 billion tons of carbon are incorporated into living plants ("fixed") on land. Each year 180 billion tons of carbon are fixed in life in the ocean, mostly by algae, one-celled plants that do not have leaves.

Food chains and food webs provide an opportunity to discuss the idea of interdependence. Because animals may eat more than one kind of plant or animal, a food **web** more accurately represents the natural interactions of living things.

Typically, 90% of the energy received as food by one step in a food chain is not passed on to the next step. Therefore, the higher an animal is in a food chain, the more sunlight needed to provide it with energy.

Resources

An excellent compendium of lessons on energy and food is available for a $5 check (make checks payable to the Energy Food and You Program) from

Energy, Food and You Program
2000 NE Perkins Way
Seattle, WA 98155
Attn: Tony Angell or Sue Palmason

Their phone number is (206) 365-0433. Ask for **Energy, Food, and You** and specify which edition (elementary or secondary) you want.

Copies of the Project for an Energy-Enriched Curriculum's unit **Agriculture, Energy, and Society** are available free from DOE/TIC; P.O. Box 62; Oak Ridge, TN 37830. This unit is intended for 10th and 11th graders.

Notes

43

ENERGY FLOWS IN NATURE

Fossil Fuels, Stored Up Energy

Days Required ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ■

For this learning sequence, your students will need: **Energy 83** pages 10 and 11. **TaE** worksheet 3-7.

Student Learning Outcomes

- Students describe the process by which coal is formed and, in general terms, the length of time required for the process.
- Students describe one way in which oil and gas may have formed.
- Students recognize the fossil fuels as a store of energy.

Suggested Teaching Strategy

Coal is formed from plants in a process that requires special conditions and millions of years. Prepare your students for learning about how coal is developed by asking them to discuss how the coal we now have might have been formed. Read page 10 in **Energy 83** and study the series of pictures. How did the process of coal formation begin? What happened to cause the peat to harden? Why are there different kinds of coal? Coal is found in seams or layers. How can you explain these layers? About how long did it take for our coal resources to form? Do you think coal is being formed now? If so, why are we concerned about using up our coal supply?

Most geologists think that oil and gas are formed in a long process that begins with small marine plants and animals. Ask your students to read page 11 in **Energy 83** and study the picture sequence. Review the reading by posing a problem. Imagine that you are looking for oil. What kinds of clues might help you to decide where to look? In what kinds of environments was oil formed? How do these environments differ from that in which coal was formed? What kinds of rocks would be typical of an area in which oil is deposited? What kinds of fossils might you expect to find in an oil-rich area? How long did it take to form our present oil supply? Do you think oil is still being formed? If so, why are we worried about running out of oil?

Fossil fuels play an important part in our lives and their role has changed.

Ask students to complete **TaE** worksheet 3-7. Review the responses to the worksheet questions to emphasize that we use fuels for many purposes. Some of these purposes were unknown to earlier cultures. Much of the energy we use today comes from fossil fuels—coal, oil, and gas—energy sources that took millions of years to accumulate.

We are now ready to look at human use of individual fossil fuels.

Notes

Mini-Quiz

1. Coal is mostly made up of which chemical element?
2. The energy we get from coal originally came from what kind of energy?
3. What is the name given to materials like sand and clay when they are deposited at the bottoms of lakes and oceans?
4. What do we call plant remains that are in the first stage of changing to coal?
5. Rocks are often classified as igneous, sedimentary, or metamorphic. In which type is oil most likely to be found?
6. Why did the plants that turned to coal not rot after they died?
7. Why is anthracite most often found in mountainous areas?
8. How long ago did most of the plants that have become coal grow?
9. Where do we think the plants and animals that became petroleum lived?
10. How is crude oil held in a rock?

True or False?

1. Over a long period of time, and under great heat and pressure, the layers of plant materials that are becoming coal grow thicker and thicker.
2. Crude oil is a mixture of different substances.
3. There will never be more coal or oil formed on earth.
4. Studying fossils in rocks helps geologists locate oil.
5. It takes millions of years to make a layer of coal.
6. Coal is found between layers of sedimentary rock.
7. Natural gas is sometimes found beneath the oil in an oil deposit.
8. Water is sometimes found beneath the oil in an oil deposit.
9. The layer of plant remains that was changed to coal might have been twenty times thicker than the resulting coal seam.
10. People have always relied on fossil fuels and will always be able to rely on them.

Answers

1. Carbon
2. Light from the sun
3. Sediment
4. Peat
5. Sedimentary
6. They were covered with water.
7. It is formed by the heat and pressure that is part of mountain building.
8. 300 million years
9. In the ocean
10. In pores in the rock

True or False?

1. False
2. True
3. False
4. True
5. True
6. True
7. True
8. True
9. True
10. False

Background Information

Much of the coal we now have began to form in the Carboniferous period. Most estimates today place this time at about 300 million years ago, before the arrival of the dinosaurs. **TaE** pages2-56 through 2-60 contain a simple geological time line that can help students place periods when the organic matter that has become our deposits of coal and petroleum was living organisms. Of course, conditions for forming coal were not limited to the distant past.

Resources

Since many of today's students have never seen coal, you may wish to obtain some samples to show them and to use in comparing wood burning with coal burning. If you live in an urban area, you can usually find a coal supplier in the Yellow Pages (try "Blacksmithing Supplies" or "Feed Stores"). You can also order samples from such science materials supply houses as Ward's.

Answers to the Worksheet on Pages 12 & 13

1. Fissioning atom to steam turbine to girl drying her hair.

2. Sun to corn to cow to farmer with glass of milk to farmer riding bike.

3. Sun to plants to coal seam to electrical transmission to television.

4. Sun to plankton to strata of oil deposit to gusher to gasoline nozzle to automobile.

5. Sun to dam to water heater to hot water faucet.

6. All the conversions produce waste heat:
   a) The energy in the candy bar is partly converted to heat in the rider's body.
   b) Part of the motion of the generator is converted to heat, part to electricity.
   c) The brakes convert the motion of the bicycle to heat.
   d) When the bicycle crashes, all its energy of motion is converted to heat.

7. Because the furnace was 50% efficient, just as much heat went up the chimney as went into the air. So the answer is 10,000 joules. The student should be able to see that so far as this problem goes, the size of a joule, or even what it is, is irrelevant.

8. If a 10% efficient machine were fed $8,000 worth of energy, (10% times $8,000 =) $800 worth of energy would be used by the machine.
   If the machine were 40% efficient, it would only take $2,000 worth of energy to yield (40% times $2,000 =) $800 worth of energy used.
   Intuitively, the machine that is four times better will use one-fourth the energy.

YOU HAVE NOW COMPLETED A SURVEY OF ENERGY FLOW AND EFFICIENCY

Notes

FOSSIL FUELS

Coal

Days Required ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need:
Energy 83, pages 14 and 15.
TaE worksheet 3-12, 3-36
TaE reading 3-11, 3-19 through 3-21.

Coal: the once and future king?

Student Learning Outcomes

- Students give examples of how people have found new uses for energy throughout history.
- Students give examples of early uses of coal and suggest a reason why coal use developed in Europe before it did in the United States.
- Students list three reasons why people preferred using oil and gas as fuels to using coal.
- Students identify the generation of electricity as the major use of coal in the United States today.

Suggested Teaching Strategy

People have always needed energy, but through the ages we have added new uses for energy. Make a list with your students of ways we use energy today. Contrast these uses with energy uses in an earlier culture. How are our energy uses different from earlier ones?

The use of coal instead of wood made possible the rapid growth of the modern industrial economy. Ask your students to read the brief history of the use of coal that is found on pages 14 and 15 of Energy 83. What evidence is there that the use of coal and the development of machine technology grew together? Begin with some early history. Modern, intensive use of coal began in England. For what was coal first used in Great Britain? What were objections to its use? What metal was made abundant by the use of coal? Why was this metal important? Summarize the reading and discussion by making a timeline of the events described on page 14 of the student book. The timeline will look like this:

1300	coal use begins in England
1709	Abraham Darby perfects a way of using coal to make iron, by making the coal into coke
1769	Watt's steam engine

As a library assignment or as an assignment for students who have encyclopedias at home, ask the students to find the dates of other events in the Industrial Revolution. Looking up **inventions** in the encyclopedia should help. You may need to devise a list for students to research. Some developments students might date are:

Savery's steam engine (1698)
Newcomen's steam engine (1712)
Arkwright's water frame for making yarn (1769)
the first steamboat (1783)
Cartwright's power loom (1785)
the cotton gin (1793)
the steam locomotive (1800)
improvements in making Portland cement (1824)
first public railroad (1825)
Bessemer steel process (1856)
the automobile (1887)

Although not all of these developments used coal directly, many of them depended on the use of iron, which was made more abundant by using coal as a fuel. Your timeline should be enough to illustrate the rapid growth of industry after the increased use of coal made possible abundant supplies of iron and steel.

There are advantages and disadvantages to the use of coal. Your students have read the account of King Edward I and his banning the use of coal. Why did the Londoners find the use of coal objectionable? Ask your students to think about places where coal is heavily used today (such as Pittsburgh). What problems are related to the burning of coal?

TaE lesson 3-11 provides the text of the proclamation of Edward I in 1307, and develops the idea that coal is useful but its polluting nature is a problem.

Many students have never seen a piece of coal. They can get a feel for some of the advantages and disadvantages of coal as a fuel by comparing burning coal to burning wood (an equal amount). This must be done in a well-ventilated area. Guides to observing burning coal and wood are on **TaE** worksheet 3-12.

Coal is no longer our chief energy source; gas and oil are. This can easily be seen by asking your students to name ways we use coal and ways we use gas and oil. Make a chart of the uses of both energy sources. It will soon become apparent that coal has been largely replaced by oil and natural gas as energy sources in the American economy, except for the production of electrical energy. Ask your students why this is so. Call attention to the amount of coal available in the United States. Make a list of the machines your students can name that use oil or natural gas. Compare that with a list of machines that use coal. Select some of the machines listed and try to decide where in the machine the fuel is burned to provide the energy used. Your students will see that the use of oil rather than coal is influenced by the number of internal combustion engines used in our society.

Extension
The reasons for the replacement of coal by gas and oil are perhaps best appreciated by students by comparing the use of the fuels in a residential setting. **TaE** readings 3-19 through 3-21 illustrate why housewives preferred a gas stove to a coal one.

Extension
The development of the internal combustion engine was one of the chief reasons why consumption of petroleum increased much more rapidly than that of coal. **TaE** activity 3-36 illustrates the advantages of the internal combustion engines over the coal-burning

steam engines, and worksheet 3-37 helps students recognize how big a part internal combustion engines play in our present uses for energy.

Because of our large coal reserves, we may someday return to the use of coal for much of our energy. Ask your students to look again at page 15 of **Energy 83**. The small map indicates where our coal reserves are found, and the text on this page describes the polluting nature of coal and some of the things that are being done to make the mining, transport, and use of coal more efficient. Ask your students to discuss arguments for and against increasing our use of coal. You might organize the students into two teams for a debate on the issue of increasing our use of coal. The discussion can lead to comparing the size of coal resources to those of oil and natural gas. (See the next sequence.)

Notes

Mini-Quiz

1. What was the name of the first machine that was able to change the energy in coal into usable mechanical energy, or work?
2. In the 1700s, the English perfected a way of using coal to produce what metal?
3. What were King Edward I's objections to burning coal?
4. Which type of coal mining is most common in the western United States?
5. Which type of coal mining is most dangerous?
6. Which type of mining recovers more of the coal in a seam?
7. Name one substance in coal that produces pollutants.
8. Coal was first used as a substitute for what fuel?
9. For what purpose is most coal burned in the United States?
10. In what decade did coal overtake wood as America's chief energy source?

True or False?

1. At the time of the American Revolution coal was the major energy source in America.
2. At the time of the Second World War coal was the major energy source in America.
3. Coal mined in the eastern United States usually contains more sulfur than coal mined in the western United States.
4. The United States has much more coal than oil.
5. Surface mining is more dangerous than underground mining.
6. Coal will soon supply all our energy needs.
7. All the pollution problems created by burning coal are the result of sulfur in the coal.
8. Coal is now the major source of energy in the United States.
9. It is possible to make gasoline from coal.
10. In the last hundred years there have been no improvements in designs for coal-burning furnaces.

Answers

1. The steam engine
2. Iron
3. It was dirty and the smoke smelled bad.
4. Surface mining
5. Underground mining
6. Surface mining
7. Sulfur
8. Charcoal
9. To generate electricity
10. The 1880s

True or False?

1. False
2. True
3. True
4. True
5. False
6. False
7. False
8. False. Oil is.
9. True. The Germans did so during World War II and the South Africans do so now.
10. False

Background Information

Today we are used to technological revolutions taking place within only a decade or two. The advent of the transistor, computer, and jet airplane are examples. During the Industrial Revolution, the pace of change was much slower. Almost a hundred years passed from Darby's discovery of how to employ coal to make marketable iron until the use of coal in iron smelting was universal. The first practical steam engine was made in 1698, but not until the 1780s was Watt's improved engine widely used for purposes other than pumping. Students may wish to discuss why innovation proceeds more rapidly in some times and places than in others. (Consider such factors as communication systems, the availability of capital, the attitude toward innovation...)

Notice that in Britain coal and the steam engine contributed to each other's spread, somewhat as coal and the locomotive did in the United States. In its first century, the steam engine was used mostly to pump, not to rotate a shaft. The pumps were needed to drain the coal mines, because the shallow coal had already been mined out, and the deeper coal was subject to flooding. Without the steam engine, the deep coal could not have been mined. Without coal, there would not have been enough wood to run the growing numbers of steam engines.

The Transition to Coal in the United States

One of the distinctive features of the energy history of the United States is that wood was the chief fuel for almost a hundred years longer here than in other Northern Hemisphere industrial nations. Students can usually figure out why this was so. It may be important to point out that in some nations wood and other plant matter is still the primary source of inanimate energy, even in industry. For example, 40% of the steel in Brazil is presently made with wood charcoal.

Estimates of U.S. Coal Reserves

The United States is believed to have larger coal reserves than any other country, and we have more coal than anything else. It is not meaningful to compare reserves of mineral energy sources in terms of physical units like barrels or tons because a ton of petroleum may yield more energy than, say, a ton of coal. But we can compare our reserves of different mineral energy resources by converting the estimates of the physical quantities of reserves into the amount of heat that could be obtained from them. Here is how the total "heat reserve" breaks down:

Mineral Energy Sources	Percent of total "heat reserve"
Coal	81.7%
Petroleum	2.8%
Natural gas	3.5%
Natural gas liquids	0.6%
Bitumins and shale oil	7.2%
Uranium oxide*	4.2%

* This assumes the uranium is used in the kinds of reactors operating today and that the price is not more than $30 a ton. If the uranium were used in breeder reactors so that the 99% of the uranium which is U-238 could be "burned," it would provide more heat than any other source.

Transporting Coal

In the U.S. in 1976, 64% of the coal mined was moved from the mine to the point of use by rail, 13% by motor vehicle, and 10% by barge, and 12% was moved as electrical energy generated in power plants at the mine mouth.

Increased use of coal naturally means an increased need for transportation. "Unit trains" that carry only coal are one efficient means of moving coal, but the towns through which the railroads pass are concerned about the effects of what might become continual rail traffic.

To transport coal by pipeline, the coal is ground very fine and mixed with water, or sometimes oil, to form a slurry. Two such pipelines have been operated successfully.

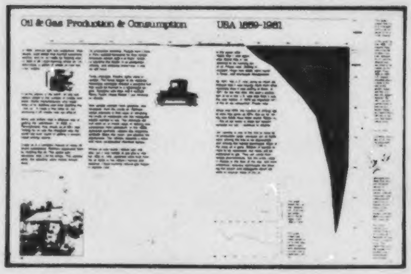
Making synthetic liquid and gaseous fuels from coal is another solution to the need for fuels for transportation, and it is also a means of reducing the pollution created at the point where the fuel is burned. Making a fuel gas from coal is a two-century-old industry. Once, most gas sold by utilities was synthetic, but it had no more than half the heating energy per cubic foot of natural gas. However, gas with a heating value comparable to that of natural gas can be made.

FOSSIL FUELS

Oil and Gas Production and Consumption

Days Required ■ ■ □ □ □ □ □ □ □ □ □ □

For this sequence, your students will need:
Energy 83 pages 16 and 17.
TaE reading 3-25.



Student Learning Outcomes

- Students define "depletable."
- Students identify oil and gas as depletable resources.
- Students identify the United States as one country in which oil production has probably peaked.
- Students relate the price of oil products to the cost of oil production, and recognize that the production costs rise as the most readily available sources are depleted.
- Students describe the rate at which United States oil imports have changed in recent years.

Suggested Teaching Strategy

Our use of petroleum has changed greatly in the last 100 years. Students can see this by reading pages 16 and 17 in **Energy 83.** Read these pages and discuss the history of oil use. Why do people need artificial light? What are some of the ways that have been found to get artificial light? Why would people who lived 200 years ago have wanted to drill wells for brine? What do we mostly use petroleum for today? How do we get the oil we use?

Extension
One of the chief causes of the increased use of petroleum was the rise of the internal combustion engine, which required a powerful, volatile, liquid fuel. **TaE** 3-25 provides a reading illustrating the advantages early inventors of motor cars saw in gasoline.

The United States was once an oil exporter but now imports a great deal of the oil it uses. Study the graph of oil imports and exports on pages 16 and 17. What color on the graph indicates oil exported from the United States? What color represents imported oil? What did people use oil for in 1880? Why did we become oil exporters then? When did the United States begin to buy more oil than it sold? In what year did the country import the most oil? What might account for the decline in imported oil in the last three years?

We still have considerable oil reserves. The map of U.S. oil fields on page 17 and the text just below the map suggest that we have a great deal of oil. Studying the map and reading the short account of U.S. reserves may make some of your students wonder why we are importing oil. Take this opportunity to discuss the conditions of our reserves and to point out the economic factors. We can indeed still recover U.S. oil if the cost of reaching this oil is comparable to the cost of importing oil.

Our oil production has probably peaked. Look at the two graphs at the bottom of page 17. One shows the oil production levels in the United States. The graph indicates a flattening of oil production in recent years. The second graph deals with productivity and shows the declining ratio of oil produced to feet of well drilled. Ask your students to discuss the significance of the data in the two graphs. What does the combination of lower production and of more drilling mean in terms of the cost of oil and its availability to the consumer?

TaE lesson 3-45 describes a simulation activity to be done by a whole class. It requires an entire period, but is popular with students and demonstrates effectively why it is usually the case that the more of something we extract the more difficult further extraction becomes.

Notes

Mini-Quiz

1. When oil was first obtained by drilling wells, what was the most important use for the oil?

2. What historical development changed gasoline from a useless by-product to a highly sought after product?

3. What is the name of the factory that converts crude oil to gasoline and other petroleum products?

4. In what decade did the United States begin to consume more oil than it produced?

5. In what decade did domestic production of petroleum decline for a number of years?

6. What country was the largest exporter of oil in the early years of petroleum production?

7. Recently, the amount of oil we import each year began to decline. In what year did we import the most oil?

8. What do we call special ways of getting more oil out of old wells that have stopped producing?

9. Besides being burned as fuel, petroleum is used to make lubricants. Petroleum is also made into a material from which many objects are manufactured. What is that material called?

10. Give two reasons why we can't be absolutely certain how much oil will ultimately be pumped out of the ground.

True or False?

1. Most oil estimated to be still in the ground in the United States is offshore.

2. The more people are willing to pay for oil, the more barrels of oil we will get out of the ground.

3. The American oil industry began in Pennsylvania.

4. There is no more oil to be discovered in the United States.

5. There have been times in the past when Americans believed they were running out of an energy resource.

6. Hardly anyone bothers to look for oil in the United States today.

7. By the time of the Civil War, the oil industry was the biggest business in America.

8. By 1900, long distance natural gas transmission pipelines reached most of the United States.

9. The invention of the electric light had an effect on what refineries did with the crude oil they received.

10. Until Drake's well was drilled in 1859, no one had ever seen crude oil.

Answers

1. As kerosene for lamps
2. The invention of the internal combustion engine and the spread of the automobile
3. Refinery
4. The 1940s
5. The 1970s
6. The United States
7. 1977
8. Secondary recovery, enhanced recovery, or tertiary recovery
9. Plastic
10. a) We can't know for certain how much petroleum is in the ground.
    b) We don't know how much people will be willing to pay for it, and that determines how much we can spend getting it out.

True or False?

1. False
2. False
3. True
4. False
5. True
6. False
7. False
8. False
9. True
10. False

Background Information

Petroleum was bought and sold in America in the 1700s, long before Drake's well. It was obtained from seeps and by skimming pools and creeks, and was often called Seneca Oil. In 1814, a brine well being drilled at Rennix Springs, Kentucky, struck oil at 475 feet. The crude flowed out into a nearby river, where it ignited in a blaze that stretched for fifty miles downstream.

But Drake's well is rightly credited with starting the oil industry, perhaps because it happened to be drilled in one of the largest shallow fields ever found. Not only that, but the oil was "sweet," a type that could easily be converted to lamp oil by the primitive refining methods of the day. And by Drake's time a market for oil had been established through the work of refiners who had been manufacturing a lamp oil from coal.

The Internal Combustion Engine

In 1908, Ford brought out the Model T at a price of $850. Buyers found it was reliable, and the price kept falling. By 1914 it was selling for $490. In its eighteen years of manufacture, 15 million Model T's were sold in a country with few all-weather roads. Widespread ownership of cars created a demand for better roads; better roads created a demand for a different kind of car than the high-axle Model T. In many other ways, the automobile remade American society.

ENERGY FROM NUCLEAR FISSION

Days Required ■ ■ ⬓ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need: **Energy 83** pages 18 and 19.

Student Learning Outcomes

- Students list the parts of an atom.
- Students describe radioactive decay as as change involving the nucleus of the atom.
- Students describe a chain reaction.
- Students describe how nuclear fission is used to generate electricity.
- Students list some advantages and disadvantages of using nuclear reactions to provide energy.

Suggested Teaching Strategy

In order to understand nuclear reactions, we must know something about the structure of the atom. Begin the study of nuclear energy by reviewing the parts of an atom. Ask students to read the first section of page 18 in **Energy 83** and define these terms: nucleus, proton, electron, neutron, isotope, radioactive decay, and nuclear fission. The reading uses hydrogen to illustrate isotopes. Be sure your students know that isotopes of a particular element have the same number of protons and behave the same way in chemical reactions, but have different numbers of neutrons and behave differently in nuclear reactions such as radioactive decay.

TaE lesson 4-5 provides a simple activity reviewing the names of the particles and the structure of the atom, and provides for the creation of a series of diagrams which may be useful in later discussions.

Atoms of some isotopes spontaneously change from one element to another, and release energy as they do so. We call this radioactive decay. Using students' knowledge of the particles in the nucleus, explain to the class that in nature some isotopes are changing to other elements all the time, by reactions that change the number of protons in the nucleus. The energy released comes from changing matter to energy.

Extension
Many students have heard the equation $E = mc^2$. **TaE** lesson 4-21 shows how this equation can be used to calculate how much energy will be released in radioactive decay. To follow the lesson,

students must be able to work easily with very large and very small numbers, and with formulas that involve squares.

Extension
A convenient way to state the rate at which a radioactive isotope changes into another isotope is to give the half-life of an isotope—the time required for half of the nuclei in any sample to change to another element. **TaE** 4-13 provides an activity illustrating half-life and reviewing the nature of radioactive decay.

In one special kind of radioactive decay, a nucleus splits, making two new atoms. This is called nuclear fission. Reviewing the reading on page 18, what role does the neutron play in causing an atom to fission? Can any isotopes of any element be made to fission? How does the release of new nuclei heat the surrounding material?

To make nuclear fission work for us, we must establish conditions for a chain reaction. Use the pictures and reading about chain reactions on page 18 to identify the steps in a nuclear chain reaction. A neutron strikes a nucleus. The nucleus splits, releasing more neutrons. They strike other nuclei and other neutrons are released in a geometrically growing number. Ask students to review the reading and describe how such a reaction can be controlled.

In a nuclear reactor, the release of neutrons is controlled. The result is a constant energy source that can be used to generate electricity. Study the diagram of the reactor on page 19. Establish the flow of energy. Where is the radioactive fuel? Point out that the control rods are made of neutron absorbers, and are one of the ways used to control the number of neutrons in flight at any one moment. How does that control the rate at which the reactor produces heat?

In a nuclear power plant, heat produced by nuclear fission is converted to electricity. What form of energy is released when the fuel in the reactor decays? How is this energy transferred from the reactor core? How is it changed into electrical energy? Draw a diagram on the chalkboard and trace the flow of energy and the various conversions from one form of energy to another.

There are advantages and disadvantages to the use of nuclear fission as a source of useful energy. Some of these advantages and disadvantages are described on page 19 of **Energy 83**. With your students, make one list of the advantages and one of the disadvantages listed in the reading. Then add any other items the class may suggest. You may wish to close this sequence with a discussion of whether the advantages outweigh the disadvantages. Compare nuclear fission with other energy sources.

Mini-Quiz

1. What is the inner part of an atom called?
2. Name the two main particles found in the nucleus of an atom.
3. What is the correct term for "splitting the atom"?
4. The rate at which an operating nuclear reactor produces energy is controlled by controlling the number of what?
5. In what form is energy removed from the core of a nuclear power reactor?
6. What do we call it when the fissioning of one atom causes other atoms to fission, and they cause still others to fission, and so on?
7. What is the name of the type of reactor in which extra neutrons are used to change an isotope that cannot be used as fuel into one that can be used as fuel?
8. Name one natural source of radiation.
9. A beta ray consists of what particle?
10. Uranium-235 and plutonium-239 are both radioactive. What else do they have in common?

True or False?

1. The nucleus of one atom has three neutrons and two protons. The nucleus of another atom has two protons and two neutrons. They are atoms of the same element.
2. The number of protons in an atom's nucleus is all that determines what chemical element it is.
3. It is possible for some chemical elements to change into other elements.
4. A commercial power reactor could explode like an atom bomb.
5. Some elements have some isotopes that are radioactive and some isotopes that are not.
6. Any isotope that can spontaneously change into another element is radioactive.
7. A major consideration when using radioactive materials is what to do with the radioactive waste.
8. Today's nuclear power reactors can use any radioactive isotope as fuel.
9. It is impossible for any human being to avoid some exposure to radiation.
10. For the nation as a whole, using coal is the chief alternative to using nuclear fission.

Answers

1. Nucleus
2. Neutrons and protons
3. Nuclear fission
4. Neutrons
5. Heat
6. Chain reaction
7. Breeder 8. Cosmic rays, the decay of radioactive atoms in such substances as soil, food, fossil fuels, or building materials...
9. An electron
10. They can be split by slow-moving neutrons

True or False?

1. True
2. True
3. True
4. False
5. True
6. True
7. True
8. False
9. True
10. True, under present conditions; coal and nuclear power are the only immediate choices for large-scale electrical power generation. However, other alternatives may become competitive in the future.

Background Information

Isotopes

The two isotopes of hydrogen have their own names: deuterium (one neutron) and tritium (two neutrons). Tritium is the material used in the digital LCD watches that glow in the dark (the decay provides the energy for the glow).

Radioactive Decay

When a nucleus decays, it turns into a nucleus of another chemical element because there is a change in the number of protons. Radioactive isotopes have characteristic ways of decaying, each way producing some particular new isotope. The rate at which this change occurs is also characteristic of each isotope.

The dating of rocks and archaeological remains depends on knowing the half-lives of the isotopes they contain. When a rock is formed, it probably contains at least one minute amount of a radioactive isotope. As time passes, the amount of this isotope decreases and the amount of the new isotope increases. By comparing the two quantities, an estimate can be made of the time that has passed.

Nuclear Fission

While uranium nuclei can be fissioned by bombardment with neutrons, they also fission spontaneously.

Isotopes that can be fissioned by a neutron are called fissionable; fissionable isotopes that can be fissioned by a slow-moving (thermal) neutron are called fissile. There are only three fissile isotopes and only one of these, uranium-235, is found in nature.

Radiation and Life

Very large doses of radiation kill outright, but this is not what people are worried about. Only seven people have died of acute radiation poisoning in the entire course of U.S. nuclear energy use, all of them workers in the industry. Instead, the main question is what effect low doses of radiation over long periods of time will have on a large population.

Radiation has two kinds of effects on people. First, radiation affects the cells of the body directly. More and more of the survivors of Hiroshima got leukemia as time passed, beginning several years after the blast. Almost all the American women who painted luminous watch dials developed bone cancer from accidentally eating the radium in the paint. Sometimes radiation's effects shorten a person's life span without resulting in any particular disease. Decades ago, radiologists had a shorter life span than other white male Americans. Gradually, standards on how much exposure was considered acceptable were made more stringent and, as this happened, the average life span of radiologists increased until it now exceeds the average of other white American males.

The second type of damage is genetic, in which the eggs or sperm of the person exposed are altered. The effects may then show up in damage to the newborn child, or as a spontaneous abortion.

The faster cells are dividing, the more susceptible they are to radiation damage. That is why radiation is a useful treatment for cancer; it kills fast-growing cancerous tumors faster than it kills the normal slow-growing tissue. It is also why doctors are reluctant to x-ray unborn children.

In general, a given amount of radiation received in a single dose is more harmful than the same amount of radiation spread out over a period of time.

Background Radiation

Increased use of nuclear power has increased our concern about radiation. One of the clearest ways to compare the effects of different sources of radiation was devised by the United Nations Scientific Committee on the Effects of Atomic Radiation, which every five years tries to summarize these effects. For each source, they estimate how many days of exposure of the world population to the natural background radiation would be necessary to equal the exposure the world population gets from that particular source. For example, three days' exposure of the world's population to natural radiation to equal the exposure they get in one year of exposure to radiation-emitting consumer products.

Source of Exposure	Days of exposure to natural background radiation needed to equal exposure to this source
One year of commercial air travel	0.4
Use of one year's production of phosphate fertilizers at the present rate	0.04
One year's global production of electrical energy by coal-fired plants at the presently installed capacity	0.02
One year's exposure to radiation-emitting consumer products	3.0
One year's production of nuclear power at the presently installed capacity	0.6
One year of nuclear explosions averaged over the period 1951-1976	30.0
One year's use of radiation in medical diagnosis	70.0

This table is the exposure table for the earth as a whole. The figures would be higher for Americans because we have more consumer goods, medical care, air travel, etc., than the average human being.

Watches, early color TV models, and smoke detectors are examples of consumer goods that produce radiation. Smoke detectors are a good example of the tradeoffs in risk and benefits to be considered concerning the use of radioactive materials. The benefit of the lives saved by early fire warnings greatly exceed the damage done by the radiation emitted by the detectors.

Atmospheric nuclear bomb tests continue. The twenty nuclear tests carried out between 1971 and 1976 increased the amount of radiation each person will be exposed to in a lifetime by 2% in the Northern Hemisphere.

Radioactive Wastes

Because radioactive wastes have been created by nuclear weapons programs, we will have to provide long-term storage even if we have no commercial nuclear power program. The volume of wastes is significant. A year's operation of a power plant that produces 1000 megawatts of electricity [1000-Mw(e)] plant at 100% capacity produces, after fuel reprocessing, 114 cubic feet of high-level wastes and an additional 72 cubic feet of cladding. (Cladding is the metal tube in which the fuel is packed to make fuel rods.) In addition, mining and processing the ore, operating the reactor, and operating the reprocessing plant result in other wastes which are less radioactive: 6900 gallons of intermediate-level wastes, 340,000 gallons of low-level liquid wastes, and 6900 cubic feet of solid wastes. In about 1000 years, the overall radioactivity of the high-level wastes will decay to the level of the original ore body, but the wastes may not be safely underground and will consist of a different set of isotopes which, not being the same chemical elements which were mined, play different biological roles in the body.

Accidents

Commercial power reactors cannot explode like bombs. All American plants are fueled with a mixture of 96½% uranium-238 and 3½% uranium-235. Bombs are made of 10% U-238 and 90% U-235 because to get a bomb to explode, the chain reaction must proceed very fast, before the material to be fissioned is blown apart.

Even if the uranium mixture used in reactors were assembled into a regulation military bomb, it would not go off. (Separating the isotopes is a very difficult process that currently requires billions of dollars of capital equipment.)

Breeder Reactors

The chief advantage of breeder reactors is that they make it possible to use the wastes from preparing uranium-235. Over 99% of the uranium mined is U-238, which can't be used as fuel. The breeder converts this waste by-product to plutonium, which can be used as fuel. (Breeders can also convert certain other isotopes to fuel.)

However, many persons have claimed it is easier to make bombs of plutonium than of U-235, although the details are secret. This raises the specter that many groups could put together atomic bombs (nuclear proliferation) if plutonium becomes common. There are alternatives involving breeder reactors which do not involve plutonium. Some breeder cycles convert thorium to uranium. And a fast breeder produces less plutonium per year than today's water reactors do because the breeder is also burning plutonium as it breeds it.

Notes

Notes

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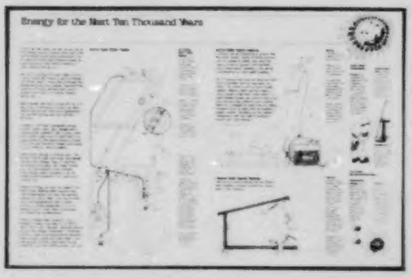
RENEWABLE ENERGY SOURCES

Days Required ■ ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this learning sequence, your students will need: **Energy 83** pages 20 and 21.


Energy for the Next Ten Thousand Years

Student Learning Outcomes

- Students describe the need for considering renewable energy sources.
- Students list at least five renewable or alternative energy sources.
- Students describe how sunlight is converted to heat by absorption.
- Students describe one method of using sunlight to meet the need for space heating in a home.
- Students diagram a system in which heat is transferred by circulating fluids and stored in thermal mass

Suggested Teaching Strategy

To ensure adequate energy for future generations, we must begin to find the most efficient ways of using all the energy sources available. Begin this sequence with a review of the energy sources available. Students will be able to name oil, natural gas, wood, nuclear fission, and sunlight (for photosynthesis) as energy sources available to us now. Ask them to imagine a time in the future when there will be many more people needing energy than there are now. More people could mean greater energy demands. List the energy sources on the chalkboard; then ask students to indicate whether they feel that, at that time in the future, there will be more of this source, less of it, or about the same amount of it as there is now. Students will soon see that the available energy for the future depends on the actions we take now. Some energy sources (oil and natural gas) will almost certainly be diminished. Some (wood, electricity from running water...) depend on our actions in building or maintaining the source. Some (sunlight...) will still be available as sources of energy for the future. Suggest that one problem is finding ways to make greater use of the sources that will continue.

Sunlight can be used for many of our energy needs if it is converted to heat energy. Demonstrate that sunlight, when absorbed on earth, turns to heat energy by placing thermometers on a black surface and on a white surface in sunlight for a few minutes. Compare the temperature readings. Ask your students if they think this heat energy could somehow be used for our energy needs. In our daily lives, what do we use heat for? If we could collect this heat energy (on large enough dark surfaces) how could we transport it to places where we need it? Some students may recognize that we could move the heat by circulating a fluid.

Extension
TaE 5-5 describes an experiment in which students

measure the number of calories per minute per square centimeter that can be obtained from sunlight striking a black tin can full of water.

We now have systems for using solar energy effectively. Ask your students to look at pages 20 and 21 in **Energy 83** and to study the pictures of active and passive solar heating systems. The reading on page 20 reinforces the conclusions about energy sources that you have just reviewed and suggests that building for the future means using energy sources that are best suited for the purposes for which we use the energy.

The first diagram is of a solar water heater. Be sure your students understand this diagram. Where is the sunlight converted to heat? How is the heat circulated? Where is the thermal energy stored? What does the control box do? Why is this system called an "active" system? Compare the water heater with the active space heating system. How are they alike? How are they different?

Solar heating systems can be built that do not require any other energy source. Now ask your students to look at the picture of a passive solar heating system (page 21). Trace the circulation of heat energy in the passive system. How does it move from one place to another? How is this circulation of heat energy controlled? Let your students know that the same three elements are needed here as are found in the water heating system: something to absorb the sunlight, a system for circulating the heated material, and a way to store thermal energy.

Extension

The most important single factor to consider in exploiting the sun's energy is the direction from which sunlight comes, and how this direction changes. **TaE** provides an extensive series of lessons for developing student understanding of the sun's apparent motion. Students first learn how to describe a position in the heavens, by learning how to measure bearing and altitude angles (**TaE** 5-13, 5-15) They then use the shadow of a straw on a special graph to record the sun's altitude and bearing angles during one day (**TaE** 5-19), and transfer this data to rectangular coordinates. This builds toward an understanding of the chart which they now receive, and learn to read, a chart showing the bearing and altitude of the sun, at their latitude, during the course of a year.

Extension

Up to this point, we have been speaking of using sunlight to obtain low-temperature heat. But we can also concentrate sunlight, to reach higher temperatures. **TaE** 5-35 through 5-56 provides two lessons on this subject.

Energy sources other than petroleum, natural gas, coal, nuclear energy, and the direct use of sunlight are available to us. Among these energy sources are plants, geothermal energy, photovoltaic cells, and wind. While not all are renewable, these are at least long-lasting. The sources are outlined on page 21 of **Energy 83**. Ask your students to find the advantages and disadvantages of each source. It is important for students to recognize that each of these resources, even though they are limited by financial, time, or geographic considerations, can help ensure energy supplies for the future.

Mini-Quiz

1. The simplest way of using sunlight is to turn it into what other form of energy?
2. Around 1900, solar collectors were popular in some parts of the country. Why was their use largely discontinued?
3. What keeps a solar-heated home warm when the sun isn't shining?
4. How is heat transferred from a solar collector into a house?
5. Name a material that would be good for storing heat in a solar house-heating system.
6. What is the name of the valve in a chimney or air duct that can stop the flow of air?
7. Name a device that converts sunlight directly to electricity.
8. What is the name of the type of solar heating that does not use any pumps, and uses the house itself as a collector?
9. What is the name of the kind of reaction from which the sun gets its energy?
10. What is the name of the kind of energy we get from hot rocks in the earth?

True or False?

1. North-facing windows help warm a house.
2. More than half the energy used in homes is used to heat air or water.
3. An active solar water-heating system needs electricity to operate.
4. If we learn to use fusion energy, we will not need to develop other kinds of renewable energy sources.
5. Using solar energy only works in hot climates.
6. Sometime in the future, everyone will need a windmill.
7. A problem with passive space heating is that it cannot be controlled.
8. For many building sites, passive solar space-heating would be very helpful.
9. Geothermal energy is now being used to generate electricity.
10. Photovoltaic cells are so expensive that they are now used only on spacecraft.

Answers

1. Heat
2. Petroleum and natural gas were cheap
3. Heat is taken from storage
4. By circulating a fluid like water or air
5. Water, rock, masonry
6. A damper
7. Photovoltaic cell
8. Passive solar heating
9. Fusion
10. Geothermal energy

True or False?

1. False
2. True
3. True
4. False
5. False
6. False
7. False
8. True
9. True
10. False

Background Information

Active Solar Water Heater

When people think of solar heating systems, they are likely to think about a system like the one shown on page 20, except that most systems include some form of heat exchanger. If an exchanger were used fluid would circulate in two loops. The first loop would circulate fluid containing anti-freeze from the collector to a heat exchanger in a storage tank. The exchanger would transfer the heat to a second loop through which the drinking/cooking water would circulate.

Active Solar Space Heating

A solar space-heating system has basically the same components as a water heating system: a collector, a fluid used to transfer heat (water or air), and a thermal mass.

Passive Solar Space Heating

Passive solar space heating could have a greater impact on the nation's energy use than any of the active solar systems. Passive systems have the same three elements as active systems (collector, fluid, thermal mass), but the house itself is the collector.

The house pictured on page 21 uses what is called a Trombe Wall. Sunlight entering a glass window-wall strikes a massive wall and is converted to heat. The heat is stored by virtue of the heat-retaining properties of the masonry of the wall. Heat is transferred to the living quarters inside by radiation from the inside surface of the wall. The transfer is not controlled but will be fairly even throughout the day because of the wall's thermal inertia. Heat is also transferred by air carried by convection currents through openings at the top and bottom of the wall. This circulation can be controlled. A passive design can also provide ventilation by arranging openings in the house walls to take advantage of prevailing winds.

Plants

Plants are an important energy source in many areas of the world. But, many parts of the world are now experiencing an energy crisis caused by deforestation. In this country, some cities use plants as fuel mostly by burning wastes or by recovering methane from fermentation of sewage.

Photovoltaic Cells

These cells last for decades without maintenance. Most are made of thin slices of huge crystals of silicon. The cells were first produced for the space program. The costs have dropped dramatically as technology has improved, and will continue to drop if research efforts are successful. Efforts are being made to use mass-production techniques, to use semiconductors other than silicon, to use panels made of many smaller crystals, and to duplicate the photosynthetic process in a test tube.

Geothermal

Hot steam like that found in the geysers of Northern California is rare and valuable. More common are warm water sources. These are not as suitable for the production of electricity but are being used to warm schools, houses, greenhouses, or entire towns like Pagosa Springs, Colorado. Pollution abatement equipment is used with geothermal energy just as it must be with most other energy sources, in order to control pollutants like hydrogen sulfide and noise. Radon is another pollutant sometimes found with geothermal deposits.

Fusion

The harnessing of fusion energy has proven to be very difficult. It now appears that fusion reactors, if they can be built, will be much larger and more expensive than fission reactors. Aside from the difficulties of harnessing fusion, there are possible radiation effects from the use of fusion. The reaction produces some radioactive isotopes.

Resources

A **Solar Energy Education Bibliography (expanded)** is available for a $3.74 check made to "Sundries" from the Center for Renewable Resources, 1001 Connecticut Avenue NW, #510, Washington, DC 20036.

Notes

Answers to the Review Questions on Pages 22 & 23

1. Coal, oil, natural gas
2. Sunlight
3. Coal, oil, natural gas, sunlight
4. Coal, oil, natural gas, uranium (for nuclear fission)
5. All of them (sunlight through hydroelectric, photovoltaic cells, burning wood waste, central "power towers" and other methods....)
6. Sunlight
7. The biggest use of coal today in the United States is to generate electricity.
8. Oil
9. Coal
10. Oil and gas. Coal is also now being transported in pipelines as a slurry.
11. Coal was in widespread use before oil.
12. By a moving fluid, such as water or air (Conduction can also be accepted as an answer but only if the student can describe such a system, since they are much less common. In a systems like the Trombe Wall, the absorber is also the thermal mass and heat is conducted through the wall into the living space.)
13. The three principal chemical elements in food are carbon, hydrogen, and oxygen.
14. Coal is chiefly carbon.
15. Uranium
16. 1880 (1883 is mentioned in the text).
17. 1950.
18. 1) It is difficult to transport.
    2) It is gives off many pollutants when burned.
19. Nuclear fission
20. Coal provided the energy to make the iron and steel used for rails and rolling stock, and coal was burned in locomotives. The railroads provided a means of transporting coal from the mines to market.
21. They are afraid that increasing the percentage of carbon dioxide in the earth's atmosphere may change the earth's climates in undesirable ways.
22. To transport gas to market required the construction of a pipeline system; oil could be transported in barrels.
23. Coal
24. Thermal energy is stored in a mass, such as a rock bed, tanks of water.
25. Nuclear energy to heat to motion to electricity.
    The nuclear energy is transformed to heat in the nuclear reactor. The heat is used to make steam.
    The heat is changed to the motion of a shaft in the steam turbine.
    The motion of a shaft is changed to electrical energy by a generator.

True or False?

1. True
2. True
3. True
4. True
5. False; Drake's well was drilled in 1857; Washington was inaugurated in 1789. (In this question, the word kerosene has its modern meaning: the portion of petroleum that boils between and 180 and 320°C. However, the word was coined in 1850 by the Canadian geologist Abraham Gesner to describe a lamp oil made by distilling Trinidad pitch.)
6. True
7. True
8. True
9. True

10. False
11. True
12. True
13. True
14. False
15. True
16. False
17. True
18. False. (As is stated on page 6 of the booklet, each square yard of land receives somewhat less than one horsepower of energy while the sun is shining brightly. Assuming 100% efficiency, which is impossible, to get 50-horsepower would require 50 square yards, or a car 2 yards wide and 25 yards long! Such a car could not navigate existing streets.)
19. True
20. True
21. True
22. True
23. False
24. True
25. True

Notes

YOU HAVE NOW COMPLETED A SURVEY OF ENERGY SOURCES

Notes

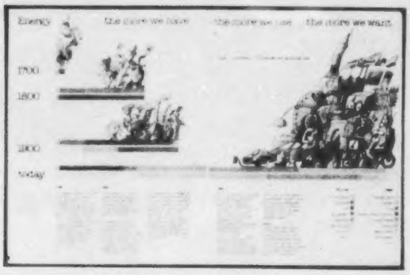
77

ENERGY IN THE UNITED STATES

The More We Have. . .

Days Required ■ ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need: **Energy 83** pages 24 and 25.



Student Learning Outcomes

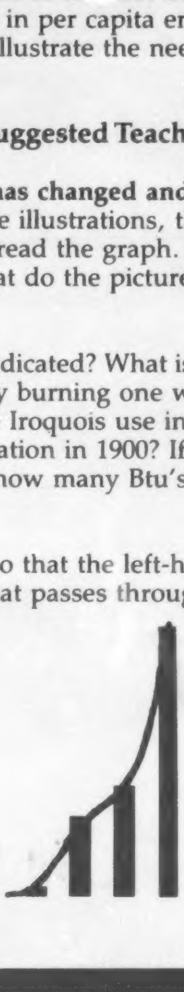
- Students describe the major energy sources used in America in the 1700s, 1800s and today; and roughly date the transitions from wood to coal and from coal to petroleum.
- Students describe how some changes in the use of energy have affected life in America, beginning at the time of the first European settlements.
- Students describe the growth in per capita energy use in America.
- Students give examples that illustrate the need for planning ahead when considering energy use.

Suggested Teaching Strategy

Over the years, our energy use has changed and is changing. Look at pages 24 and 25 in **Energy 83.** Ignoring the illustrations, this is simply a horizontal bar graph. Be sure the students can read the graph. Where is the key? What do the colors of the bars represent? What do the pictures represent? What did people use energy for in 1700?

Where is the scale of the graph indicated? What is the scale? (A Btu is approximately the amount of energy released by burning one wooden kitchen match completely.) How many Btu's did the average Iroquois use in 1700? How many Btu's did the average person use for transportation in 1900? If the vertical lines on the bar graph are one centimeter apart, about how many Btu's of energy does a person use for transportation today?

Now turn the graph on its side so that the left-hand margin is on the bottom. Ask your students to draw a curve that passes through the tops of the bars. It will look like this:



Examining the line just drawn can lead to two important questions. How long can our use of energy continue to accelerate? What are some areas we can look to improve our energy use? Ask your students questions that will lead to these issues:

In 1900, which used more energy per person—transportation or industry?

Which uses more energy per person now—transportation or industry?

In 1900, which source produced more energy per person—hydropower or wood?

Which uses more energy in our homes today—cooking or water heating?

Which energy sources appear on the graph for the first time in 1800? In 1900? In 1979?

How does the amount of energy used per person in 1979 compare to the amount used in other years shown on the graph? Build an understanding that both the number of people and the amount of energy used per person have grown rapidly.

Extension
In recent years, historians have become increasingly interested in studying how people lived in the past. **TaE** provides primary source materials you can use to give your students a chance to learn how earlier American societies used energy.

Age of Wood
6-07 What energy sources were used by the first European settlers of Virginia?
6-13, 6-16 What energy supply problems were experienced by the colonists in the late 1700s? What solutions did they explore?

Transition from Wood to Coal
6-32 When did transportation switch from wood to coal?
6-34 through 6-57 How did the Great Plains pioneers use energy to meet their daily needs?

Transition from Coal to Petroleum
3-19 through 3-21 Why did housewives prefer gas to coal?
3-25 Why did inventors of automobiles choose gasoline as a fuel?

Studying the history of U.S. energy use should lead to a realization that Americans need to be concerned about energy issues, particularly those that bear on energy resources for the future.

There are limits to how fast we can change our energy sources and uses, so we must plan ahead. Past transitions from wood to coal, and from coal to oil and gas, each took about 60 years. For example, it takes about ten years to develop a new oil field, ten years to build a new electrical power plant, more than five years to open a coal mine, and so forth.

It also takes time to improve the efficiency with which we use energy. Ask the students how long a new house can be expected to last, before being replaced? Are old houses as well insulated as new houses? For how many years will the average car be used before it is junked? Once we have invested in a house or a car, we don't scrap it just because more efficient models become available. But as better insulated houses are built, the total housing stock gradually becomes more efficient. Gradually, the fleet of all the cars on the road becomes more energy-efficient.

What are some of the things we could be doing now? The problem of ensuring energy supplies for future generations requires careful planning for efficient energy use now and beginning now to develop resources for the future.

Extension

Lead Time

Most students find it difficult to appreciate how long it takes to make some kinds of changes in energy it takes to use. For example, a major power plant that is to supply electricity in the year they graduate from college must be under construction now. **TaE** lesson 6-69 describes an activity that helps students understand why so much time is required. It also acquaints them with the variety of considerations that go into building such a plant, and exposes them to a useful planning tool. Students first learn a simple form of flowcharting by putting in order the steps involved in baking a cake (**TaE** 6-75). Then they apply the technique to the tasks involved in a much more difficult project—building a large power plant (6-77). This activity requires about a week.

The worksheet on page 28 provides some drill in reading graphs and reviews the highlights of the history of energy use from 1700 to 1979.

Mini-Quiz

1. What was the chief fuel in 1800?
2. What was the chief fuel in 1900?
3. What is the chief fuel today?
4. In 1800, which used more energy—homes and stores, or industry?
5. Which uses more energy today in our homes, offices, and stores—space heating or water heating?
6. What invention allowed the Americans of 1800 to get more useful heat from burning wood?
7. What was the chief method of transportation in 1700?
8. What was the chief source of energy for transportation in 1800?
9. What new methods of transportation contributed to the increase in energy use from 1900 to today?
10. On a certain bar graph, one centimeter equals 10 million Btu. Today, each person uses an amount of energy represented by a bar 36 centimeters long. How much energy does each person use in a year?

True or False?
(Allow students to refer to the graph for answers to these questions.)

1. Between 1900 and today there has been a great increase in the percentage of total national energy consumption that is used by industry.
2. Between 1700 and 1800, the largest growth of energy use was for heat in homes, offices, and stores.
3. Waterwheels provided most of the energy used in Colonial America.
4. In 1900, Americans used more energy for heating in stores, offices, and homes than for transportation.
5. Today, we use more energy for heat in homes, offices, and stores than for industry.
6. People were using natural gas in 1900.
7. The average American uses more than ten million Btu's of energy from nuclear sources each year.
8. Our use of energy for transportation more than doubled between 1900 and 1979.
9. The amount of energy each person gets from food has not changed very much in the last two hundred years, compared to changes in the amounts each person gets from other sources.
10. Per person, we use less coal today than we did in 1900.

Answers

1. Wood
2. Coal
3. Oil
4. Homes and stores
5. Space heating
6. The Franklin stove
7. Walking
8. Food, to feed animals like horses
9. Cars, airplanes, rockets
10. 360 million Btu

True or False?

1. False
2. True
3. False, wood did. Muscle power (that is, energy from food) provided most of the mechanical energy.
4. True
5. False
6. True
7. True
8. True
9. True
10. True

Background Information

1700

The Iroquois were chosen to represent the year 1700 because they were a pre-machine, pre-fossil-fuel society. Such societies still exist. People like the Tasaday of the Philippines are less technologically advanced today than the Iroquois were in 1700.

1800

Some 1800 energy sources were too small to be represented on the graph in the student book. Some large cities such as Philadelphia and New York had begun to use coal. Water power was also in use. But wood was by far the primary energy source.

Americans of the late Colonial period used more energy per person than people in Europe, chiefly because fuel was so cheap in America. To make farms out of a virgin wilderness, trees had to be disposed of, so in many locations all the firewood one wanted could be had for the labor of cutting it. Also, the Pilgrims and Pioneers lacked capital. They did not have money to buy iron stoves, window glass, oil and lamps, or other goods that would have made possible less energy- intensive ways of doing things. In 1800, an enormous fire in an inefficient open fireplace was lamp, heater, and cooking stove to most Americans.

By 1800, this situation was changing, and the change was first felt in the cities. Wood was getting dearer, housing better, and stoves more common. The nation was poised for an industrial revolution.

1900

By 1900, America was essentially an industrial nation. Coal was the primary energy source. Petroleum was primarily a fuel for lighting. Automobiles were curiosities.

1979

Around 1946 coal lost its place as the primary energy source in the American economy.

Notice that, for 1979, the Homes, Stores, Offices category is subdivided into Space Heating, Cooking, Water Heating, and Refrigeration.

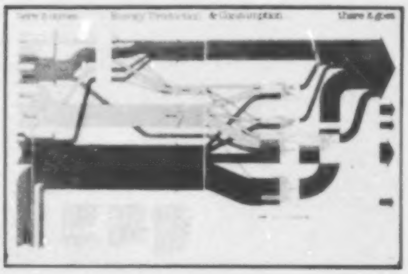
Notes

ENERGY IN THE UNITED STATES

Energy Production and Consumption

Days Required ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need: **Energy 83** pages 26 and 27.



Student Learning Outcomes

- Students list the major sources of energy used in the United States and rank them according to the percentage of energy each source provides.
- Students identify the sources of energy that now support major activities such as transportation, home heating, industry, etc.
- Students describe the overall efficiency of energy use in the United States.
- Students recognize that using rejected heat could result in more efficient energy systems.

Suggested Teaching Strategy

Analyzing energy supply and use requires information. The graph on pages 26 and 27 of **Energy 83** provides information about energy sources and what the energy is used for. Be sure that your students are able to read the graph. Begin with sources of energy.

What five energy sources are shown on the graph?

(Be sure that students understand that the width of the bar shows the amount of energy used.)

What was the largest single source of energy?
Which source of energy did the U.S. import the most of?
Which did we export most?
Which provided more energy—coal mined underground or surface-mined coal?

Call your students' attention to the scale.

Develop the idea that the dividing bars indicate energy flow for different purposes. Which of the energy sources contributed to the generation of electricity? Which source provided the most electricity? Notice the red arrow that shows energy dissipated in waste heat. On page 27 where it says "waste heat," where did the waste heat come from? Did the waste heat represent more or less energy than the amount of electrical energy produced?

The graph shows four major areas in which we use energy. What are those areas? Which area used too little electrical energy for that use to show on this graph?

Which energy source contributed most energy for transportation? Which source contributed most energy for residential use?

Toward the right of the graph, colored sections within the bars indicate more specific uses within each of the four major use areas. White areas next to these colored bars carry labels for the bars. (The labels are not always exactly next to the colored bar they identify, but they are in the proper order. If in doubt, count down from the top.)

Work with your students to read this section.

What does the yellow bar in the residential section stand for? (Energy used for space heating.)·

What color is the bar that indicates energy used for cooking in residences? (Pink.)

Now look at the information at the right of the graph. The red arrows indicate waste heat. The white arrows provide an indication of the amount of energy applied to the tasks intended. Which of the four major use areas gave off the most waste heat?

Which gave off the least waste heat? In which area is our energy use generally least efficient?

Once the students have learned to read the graph, give them an open-book exercise to let them see what other information the graph can provide. You may use the questions on page 29 of **Energy 83.** Answers to the questions on page 29 are given on page 68.

A graph like that on pages 26 and 27 can provide numerical data about energy use. Finding the number of Btu's of energy used in various ways in the United States will give your students the opportunity to apply mathematics to the study of energy. They will need a metric rule. Notice that the scale is 1 mm = 0.7 quadrillion Btu. To give your students an idea of this scale and of the rate of energy consumption, point out that a quadrillion is written in numerals as 1 followed by 15 zeros.

Now, using a metric rule, measure the largest source of energy, petroleum. How many Btu's of energy did petroleum provide? Students will need to measure the width of the purple bar at its greatest width. Using this measurement and multiplying by 0.7 Btu will reveal that petroleum sources provided about 37 quadrillion Btu of energy in 1979. Use the same procedure to find:

How many quadrillion Btu's of energy natural gas provided. (about 20 quadrillion Btu)
How many quadrillion Btu's of energy the United States used in all in 1979. (78 quadrillion.)

We need to search constantly for more efficient ways to use our energy resources. End the discussion of the graph on pages 26 and 27 by asking students to suggest areas where there might be ways to use energy more efficiently. Discuss the areas with the least efficiency and what might be done to improve them.

Mini-Quiz

1. What do the red arrows on the graph represent?
2. Rank these uses of energy from the one consuming the most energy to the one consuming the least energy.
   a. Residential space heating
   b. Chemical industry
   c. Commercial space heating
   d. Transportation by automobile
   e. Home cooking
   f. Oil refining
3. Is energy used more efficiently in transportation or in homes?
4. In 1979, which used more energy, trucks or railroads?
5. In 1979, which used more energy, railroads or airplanes?
6. What uses the largest amount of energy in residences?
7. Name two sources of natural gas.
8. Which is greater, the amount of oil imported or the amount we produce domestically?
9. Name two sources that provide energy for all four sectors: residential, commercial, industrial, and transportation.
10. What two major categories result in about the same amount of waste heat?

True or False?

1. Petroleum will always provide us with most of the energy for our economy.
2. We need to use energy for all the things shown on the graph we have just studied.
3. About half of the energy from the petroleum we use goes to power our transportation system.
4. Energy sources not listed on the graph for 1979 are unimportant.
5. Someday we may have to be concerned about the way in which we dispose of waste heat just as we are concerned about air pollutants today.
6. Much more energy is used for air conditioning than is used for space heating.
7. Nuclear fission now provides more energy than hydropower does.
8. Oil and natural gas are sometimes burned to generate electricity.
9. Refining petroleum requires a great deal of energy.
10. Much more coal is burned by industry than is used for transportation.

Answers

1. Waste heat
2. d. transportation
    a. residential space heating
    b. chemical processing
    c. industrial space heating
    f. oil refining
    e. home cooking
3. Homes
4. Trucks
5. Airplanes
6. Space heating
7. Natural gas wells, gas from oil wells
8. Domestic crude oil
9. Natural gas, petroleum
10. Transportation and generation of electricity.

True or False?

1. False
2. False
3. True
4. False
5. True
6. False
7. True
8. True
9. True
10. True

Background Information

Some students make the mistake of thinking that the top band flowing into a block must power the top line out. For example, referring to the "Transportation" block powering pipelines is not exclusively the job of natural gas. Similarly, "Residential" electricity is obviously not just used for space heating.

Answers to Questions on Page 28

1. In 1900, industry used more energy than transportation.
2. In 1979, transportation used more energy than industry.
3. In 1900, wood supplied more energy than hydropower.
4. Firewood.
5. Nuclear fission.

1. One centimeter equals 10 million Btu per person per year.
2. One millimeter equals 1 million Btu per person per year.
3. A bar 3 centimeters long would represent 30 million Btu per person per year.
4. In 1800, coal supplied too little energy per person per year for it to be visible on the graph.
5. In 1900, coal supplied about 89 million Btu per person per year.
6. In 1979, coal supplied about 68 million Btu per person per year.
7. In 1900, industry used about 42.5 million Btu per person per year.
8. In 1979, industry used about 131 million Btu per person per year.

Answers to the Questions on Page 29

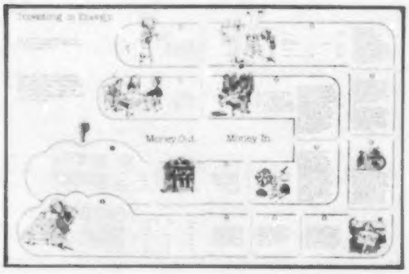
1. In 1979
2. Crude oil
3. Natural gas
4. Coal, oil, natural gas
5. Crude oil
6. Natural gas
7. Coal
8. Crude oil
9. Generating electricity
10. Industrial
11. Surface-mined coal
12. From wells drilled for gas
13. Industry
14. Primary metals, and the chemical industry
15. Transportation
16. Space heating and water heating
17. Space heating
18. Running automobiles

ECONOMICS AND DECISION-MAKING

Investing in Energy

Days Required ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence your students will need:
Energy 83 pages 30 & 31.
TaE worksheet 7-31, 7-33, 7-37, 7-77.



Student Learning Outcomes

- Students recognize that scarce natural resources, labor, and capital are always used in saving or supplying energy.
- Students recognize that every decision to invest is a choice between alternatives, and that one alternative is to receive the current interest rate.
- Students list some costs and benefits that might be considered in deciding whether to invest in an energy conservation measure.
- Students compare alternative energy conservation investments by totalling the costs and benefits over the lifetime of the investment, including interest on money saved and including as an alternative investment a savings account they could open.

Suggested Teaching Strategy

Every decision about energy involves deciding how to use scarce factors of production. The three factors of production are labor, natural resources, and capital. (Capital is whatever we have previously made which can be used to make more things or to provide services. Money is capital only in the sense that it can be traded for these things.)

Introduce the factors of production by discussion. **TaE** worksheets 7-31 and 7-33 may be used to review the factors of production. Worksheet **TaE** 7-37 emphasizes the opportunity cost (giving up alternative uses) of using the factors of production to supply energy.

Pages 30 and 31 in **Energy 83** guide students through two similar decision-making processes. The first case is an investment to save energy. The second case is an investment to supply energy.In each, people are deciding whether to make an investment, that is, to commit factors of production to one use rather than another. In these cases we talk about investing money, but money is a stand-in for the factors of production. For example, frequently people invest their time (labor) in a project without any money changing hands.

Saving energy requires investment. Point out to the students that saving energy at home increasingly involves investment. After acquiring thrifty energy habits, like turning off lights and turning down thermostats at night (where the only cost is a little of our labor), to save more energy we have to invest in measures like insulation, storm windows, more efficient furnaces and appliances, more fuel-efficient automobiles, solar heating systems, and so forth.

Investing in one thing means not investing in another. There are other things we could do with the money we spend on energy-saving measures. How can we decide which of the alternatives we should invest in?

TaE 7-73 provides a lesson on costs of saving energy, with a worksheet on page 7-77.

Susie Homeowner faces this sort of a decision. Work through the Susie Homeowner example with your students first. Understanding how she reached a decision helps students see that totalling the dollar value of costs and benefits can help us compare different courses of action. It also reveals some of the kinds of costs and benefits involved in such energy-related decisions.

Frame 1: Focusing on the Problem

First give students a chance to think about the problem and the data, then present Susie's way of making a decision by discussing the story frame by frame. Have students read the introductory sentences and frame one. Why is Susie interested in saving energy? What are some of the things a typical homeowner could do to save energy? What part does information play in the homeowner's decision? Where did Susie get information? What are some other information sources she might have used?

Frame 2: Estimated Savings

Frame 2 lists the suggestions made by Susie's utility company, the amount of the investment, and the value of the estimated energy savings in the first year. If energy costs rise, the amount Susie saves each year will increase also. Susie expects the price of energy to increase 10% a year during the 5 years that she plans to keep the house.

Make sure your students understand how the $224 and $38 savings given in the paragraph were arrived at. If Susie decides to insulate her attic, she will save $153 in energy costs the first year. But if energy prices increase 10% each year, in the second year she will save $153 plus 10% of $153. In each of the 5 years Susie will save:

Year 1		$153.00
Year 2	$153 + (.10 x 153) =	168.30
Year 3	$168.30 + (.10 x 168.30) =	185.13
Year 4	$185.13 + (.10 x 185.13) =	203.64
Year 5	$203.64 + (.10 x 203.64) =	224.00

A similar calculation shows that for insulating the crawl space, Susie would avoid $38 in utility bills in the fifth year.

Look at the numbers so far. Ask the students what they think Susie should do.

Frame 3: How to Decide?

Susie concludes that installing caulking and weather stripping is a good idea, since after deducting expenses she will clear $17 the first year and after that more than $117 a year for the life of the caulk. (Good caulk will last at least five years.)

Some alert students may point out that Susie has not put a price on her own time. This is in fact a cost.

Should she price it at her hourly wage? Only if extra work was really available at her place of employment and by spending her time caulking and weather stripping she was giving it up. For most people, this isn't true. The cost of do-it-yourself labor is the cost of the next-best use of one's time.

It isn't so clear whether she should insulate the attic or crawl space. These decisions are more like the hard investment decisions everyone faces at one time or another. Here we need a method to help show us the consequences of each course of action.

Why is the decision hard? Why do we have to decide at all? Simply because people can't do everything they might want to; they haven't enough money (for money, read the factors of production). So they have to choose.

The method we will use depends on putting a dollar value on things. Granted, it is difficult or impossible to put a dollar value on certain things (your life, for example), but even so we have to make choices. Some people get so much personal satisfaction from saving energy that they are willing to invest in an energy saving measure even if the cost of the measure is greater than the energy costs they avoid. Even such a person cannot afford to do every energy conservation measure he can think of, and so is forced to choose between different measures.

Ask your students what else they need to know in order to help Susie decide whether to invest money in insulating the attic and the crawl space.

Susie's method of comparing alternatives is to figure out, for each possible use of her money, how much money she will put out and how much she will take in during the next five years—five years, because that is when she plans to sell the house. Adding these up gives her a prediction of how much money each action will lead to by the end of the five years.

Frame 4: What Susie Gives Up Is a Cost

In deciding whether to make an investment, people always consider other possible uses of what they are investing. For example, it is harder to decide what to watch on TV when there are many good programs on than when there is only one program we want to watch.

Susie must think that at the moment the best thing to do with her money is keep it in the bank, because she has already chosen to do that rather than anything else. The chief benefit to Susie of this investment is the interest she gets. She feels safe in predicting that if left in the bank, the $750 that insulating the attic would cost will become $1155 five years from now.

Do the arithmetic with your students for leaving the $750 that insulating the attic would cost in the bank. For simplicity's sake, interest has been compounded annually.

year 0		$750.00
year 1	750 + (.09 x 750) =	817.50
year 2	817.50 + (.09 x 817.5) =	891.08
year 3	891.08 + (.09 x 891.08) =	71.28
year 4	971.28 + (.09 x 971.28) =	59.70
year 5	1059.70 + (.09 x 1059.70) =	1155.07

If you feel your students would benefit from the math activity, ask them to work through a similar pattern for placing the $200 crawl space insulation cost in the bank. Using a calculator eliminates the drudgery.

Emphasize that, if she chooses to insulate her house, Susie gives up the interest she could get by keeping the money in the bank. What practical effect does this have? Suppose Susie that in five years insulating her attic saves Susie exactly $750 on her utility bills, so that the insulation has "paid for itself." Will Susie have broken even? No, she will actually have lost $405 (1150 - 750) she might have had by leaving the money in the bank.

Frame 5

Sometimes we don't recognize all of our benefits. At the end of five years, the insulation Susie bought will still be worth something, because her house will be worth more than it would be if it were uninsulated. Susie will realize this increased value when she sells the house. (Economists call this the "salvage value.")

Frame 6

Another of Susie's benefits is a tax credit. Many energy conservation measures are subsidized by the state or federal governments, to encourage people to save energy. One type of subsidy is a tax credit, which allows a taxpayer to deduct some of the cost of energy conservation from the amount of income tax he or she owes the government.

At this point, ask students what their decisions would be. Is there anything else they would want to know, or would do, to help them reach a decision?

Frame 7

Now Susie has the information she wants to make a decision. (Be sure students understand that Susie would invest each year's savings in the bank.) The table at the right shows how Susie's original $750 investment in attic insulation will grow to $1760. Susie compares that amount of money with the amount she would have if she invested in her next-best alternative, the savings account described in frame 4. Susie would rather have the $1760 than the $1155, so she decides to insulate the attic.

Expand the lesson by asking your students what other kinds of energy conservation measures Susie might have considered (a more efficient water heater, a solar water heater, storm windows, appliance control systems. . .your students should make a good list of possibilities). What would one consider in each of these cases in deciding whether to make the investment?

Frame 8

The costs of the crawl space were greater than the benefits. (Remember the $308 is a cost too.) Be certain that your students do not conclude from this particular example that it is never worthwhile to insulate a crawl space; often it is.

Students should see the usefulness of comparing energy conservation measures by adding up income and outgo over the lifetime of the investment, assuming early returns are invested, and taking into account other possible uses of the money.

Her savings will enable Susie to make other investments, perhaps in other energy-saving measures.

The derivation of the $79 figure is given in the Background Information section.

The second example of Jack, Jane and Jim Investor concerns investment in energy supply.

Frame 1

They compare three alternatives: a firewood business, selling wind-generated electricity, or banking their own savings. The investors are going to use a method similar to Susie's to predict what the consequences of their different investments will be 25 years from now.

Frame 2: the Firewood Business

In this frame the investors try to predict what a firewood business begun with $50,000 would be worth in 25 years.
Students may wish to dispute the investors' assumptions, for example, the selling price of wood. This is fine: ask them to predict the results in 25 years using their own assumptions.

Frame 3: the Wind Generator Business

What assumptions were made here?

Frame 4: Letting Someone Else Invest for You

In this example, as with Susie, the bank serves as a stand-in for other possible uses of the money invested. (The bank can only pay interest because there are a variety of other uses that it can invest in.)

Although there were some risks in Susie's projects, there are many more risks in the projects the investors are considering. Ask the class how the bank compares to the other investments in terms of risk.

Frame 5

Solicit the students' opinions of what the investors should do.

Note that economists do not say that people invest in the project that will bring the greatest monetary return. They say that people act to maximize their satisfaction. The investors might choose to buy the windmill just because they always wanted to own a windmill.

Each of us makes investment decisions about energy. Ask the students to name some energy decisions a family might make that would involve a lot of money and would produce savings over many years. List some of the costs and benefits that one might want to consider.

Mini-Quiz

1. Why would a buyer be willing to pay more for Susie's house than they would for an uninsulated house? Would the buyer of Susie's house be making an investment?
2. Every investment involves some risk. Name a risk Susie runs when she decides to weather-strip and caulk.
3. Why can a bank afford to pay interest on money deposited in savings accounts?
4. The story says that the investors' forest might burn down or the windmill might be damaged. Is there any risk involved in depositing money in the bank? Why?
5. Often decisions must be made on the basis of best guesses rather than hard facts. Name one "best guess" that Susie has made.
6. How did the government encourage Susie to insulate her home?
7. You have some land. You think there is oil under the land, but you need a million dollars to drill a well. You offer that if anyone who will lend you the million dollars, you will repay them with a million dollars plus an extra $50,000 at the end of a year. Why is it unlikely anyone will take your offer? How can you change your offer to increase the chance of getting the money?
8. Suppose Susie decided to wait a year to choose an energy-saving project. What conditions might be different then?
9. Suppose the price of energy for home heating fell. What would that do to the difference between the price of Susie's home and an uninsulated home?
10. If Susie expected the price of fuel to rise even more rapidly, would that increase her costs or her savings?

True or False?

1. Everything we choose to do should make money immediately.
2. Whenever we decide to do something, we are giving up doing something else.
3. Given several alternative ways to save energy, the one to do first is the one on which we have to spend the least money.
4. Choosing the path that will save or earn the most money will give you the greatest opportunity to do other things later.
5. The only return you get on money spent insulating your house is the savings on your utility bills.
6. People always do whatever will make the most money.
7. If you are able to borrow enough money to make an energy-saving improvement, you should make the improvement.
8. Since the most expensive cars get fewer miles per gallon than lower-priced ones, you can't save energy by investing in a new car.
9. There are risks involved in everything.
10. Three costs of investing in a fuel-efficient automobile would be gasoline, license fees, and repair bills.

Answers

1. They would be willing to pay more because they would expect to pay less on their utility bills.
2. The house burns down and Susie's investment is lost. The caulking is of poor quality and deteriorates in a few months.
3. It invests the money itself.
4. Yes. The bank might change its rate drastically. It might even fail.
5. The price of energy will go up 10% per year. The house would sell for $500 more if insulated. She can get 9% interest at the bank.
6. By subsidizing it with a tax credit.
7. (The $50,000 represents a simple interest rate of 5%.) Investors could get a higher interest rate from less risky investments. You will need to make the interest rate higher.
8. Almost every factor could change in a year. Energy could be worth more or less, interest rates could be higher or lower, other options might be more promising. . .
9. The difference would be less.
10. Her savings.

True or False?

1. False
2. True
3. False
4. True, in general
5. False
6. False
7. False
8. False
9. True
10. True

Background Information

All numbers given in the examples (costs of insulating, of windmills, etc) are within the range of plausibility.

You will sometimes see the concept of payback period applied to making decisions about energy conservation investments. This method is adequate for making decisions about inexpensive maintenance-type expenditures, but it is not an adequate method of analyzing capital investments. We suggest that the term "payback" not be introduced.

In the examples, a 9% interest paid by the bank is assumed in order to use a market rate of interest, not a rate set by law. When there is no inflation, the market interest rate has usually been observed to be about 3%. If the rate of inflation is 7%, one would expect to be able to loan funds and receive a 10% rate of return.

The $79 difference quoted for insulating or not insulating the crawl space was arrived at by comparing these two sets of calculations:

Investing $200 in Crawl Space Insulation

Year	Money at beginning of year	Energy savings during year	Bank interest at 9%	Money at end of year
1	$0.00	$260 + $30. tax	$0	$56.00
2	56.00	28.60	5.04	89.64
3	89.64	31.50	8.07	127.21
4	129.21	34.60	11.63	175.44
5	175.44	38.10	15.79	229.33

Investing $200 in a bank at 9%

Year	Money at beginning of year	Interest	Money at end of year
1	$200.00	18.00	218.00
2	218.00	19.62	237.62
3	237.62	21.39	259.01
4	259.01	23.31	282.32
5	282.32	25.41	307.73

Resources

A good low-cost, three-week unit in energy and economics is **Energy Tradeoffs in the Marketplace,** prepared by the Washington State Council of Economic Education. For up-to-date information about the availability of this unit, contact:

Donald Wentworth
Center for Economic Education
Pacific Lutheran University
Tacoma, WA 98447

As we go to press, the Joint Council on Economic Education is just in the process of publishing a promising new unit on energy and economics. For more information, contact your state council or:

Mr. Michael A. McDowell
President
Joint Council on Economic Education
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ECONOMICS AND DECISION-MAKING

Buying Energy Abroad

Days Required ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence your students will need: **Energy 83** pages 32 and 33.

Student Learning Outcomes

- Students identify oil as the leading commodity in international trade.
- Students recognize that the United States now buys from abroad about half the petroleum it uses.
- Students demonstrate an understanding of the meaning of "balance of trade" by questioning whether it is possible to go on indefinitely buying more than one sells.
- Students suggest some difficulties that may result from our large dependence on foreign petroleum supplies.

Suggested Teaching Strategy

Petroleum and gas are traded through out the world. Look at the chart on pages 32 and 33 of **Energy 83.** How many different colors of arrows are there? What do the colors represent? What is the significance of the differences in the widths of the lines?

Petroleum is moved about the globe mostly from areas of little technology to areas of high technology. The largest amounts of petroleum come from a few areas of the world. Ask your students to find these areas and try to identify the countries from which most petroleum is exported. Write the names of these countries on the map.

The arrows on the map indicate oil and gas shipments, not oil and gas consumption. Be sure students understand that many countries also consume domestically produced oil and gas, and that such consumption does not show up in the arrows. Point out that the arrows to Japan and the United States are about the same size. Does this mean that Japan and the United States use about the same amount of oil?

At present, natural gas is not as important an import/export commodity as oil. Ask your students to review the chart on pages 26 and 27 of **Energy 83.** This chart shows that in the United States natural gas provides about half as much energy as oil does. Compare that difference with the difference in trade shown by the arrows on pages 32 and 33. Why do you think the United States doesn't import nearly as much natural gas as it does crude oil? Overall, how does the trade in natural gas or coal compare with that of crude oil? Why?

At this time, oil exporters are willing to trade oil for dollars. This is indicated by a picture on page 33. Why are oil exporters willing to take dollars for their oil?

To obtain crude oil from other countries, we must trade something for it. Oil is being exported largely from less-developed countries to more industrialized ones. Make a list of products for which people in the less-developed countries might be willing to exchange their oil. Try to indicate where these materials might come from (food and industrial tools might come from the United States, tools and the skills to use them from Europe, Japan or the USSR. . .). Might they also be willing to take ownership of farms and businesses in the United States?

Now ask your students to estimate how much imported oil is used to run their community. Estimate the quantity of imported oil by multiplying the number of people in the community by 12 barrels (the national average per capita consumption of imported oil). Translate this quantity to dollars by multiplying by $34 (per barrel). Now find an industrial product or agricultural product produced in your community. What does the product sell for? How much of this product would have to be sent abroad to pay for the amount of foreign oil used by the community?

Mini-Quiz

1. What is the biggest single item in international trade?
2. What country buys the most oil?
3. From what country does the United States import the most oil?
4. Name an African nation from which we import oil.
5. About how much did we spend in 1981 on imported oil?
6. About how much of the oil that we consume is imported?
7. Why are oil exporters willing to trade oil for dollars?
8. Name one danger to the United States from depending on imported oil.
9. Name two actions that could make us less dependent on imported oil.
10. How do the amounts of coal and natural gas traded compare with the amount of oil traded?

True or False?

1. The United States buys large amounts of oil from Africa.
2. Our oil imports cost $50 billion in 1981.
3. If it were not for OPEC, the price of oil could not rise.
4. We import and export natural gas from and to Mexico.
5. We get most of our imported oil from Canada and Mexico.
6. People in the United States need not be concerned about where the oil they use comes from.
7. The United States exports coal to Japan and Europe.
8. Australia is a coal exporter.
9. The United States imports petroleum from Indonesia.
10. The United States buys large amounts of oil from China.

Answers

1. Oil!
2. The United States
3. Saudi Arabia
4. Nigeria
5. $50 billion
6. Somewhat less than half
7. Because the dollars can be used to buy things in the United States
8. More of our resources must leave the country to pay for the oil; we are imperiled in the event of war;. . .
9. We could decrease oil use, develop more of our own resources, or find alternative energy sources.
10. Very small

True or False?

1. True
2. True
3. False
4. True
5. False
6. False
7. True
8. True
9. True
10. False

Background Information

In 1978, 14.7% of world trade, by value, was petroleum. For comparison, according to United Nations statistics the next nine most valuable categories of goods traded were: motor vehicles (6.8%), non-electric machines (3.6%), iron and steel (3.1%), clothing (2%), electrical machinery (1.9%), telecommunications equipment (1.5%), organic chemicals (1.5%), non-electric power machinery (1.4%).

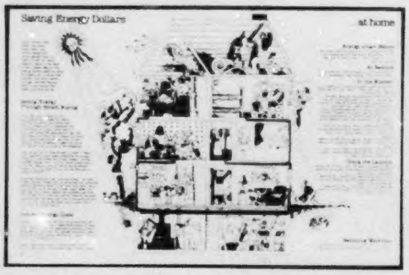
A common misstatement is that OPEC was responsible for the oil embargo of 1973 (during the Arab-Israeli War). Actually, only the Arab members of OPEC participated in the embargo; non-Arab states continued to supply oil. In addition, at the beginning, only the United States and the Netherlands were embargoed. Later Rhodesia, Portugal, and South Africa were added.

CONSERVATION

Saving Energy at Home

Days Required ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need:
Energy 83 pages 34 & 35.
TaE activity 8-9.



Student Learning Outcomes

- Students name at least three actions they could take that would reduce their family's consumption of energy.
- Students give examples of ways of saving energy through wise purchasing decisions.
- Students give an example of how recycling saves energy.

Suggested Teaching Strategy

What we do and the way we do it make a big difference in the amount of energy we use. From student suggestions, make a checklist that students can use to see if they use energy efficiently at home. Read pages 34 and 35 and add any suggestions to the list that the students might have missed.

We can all probably become wiser users of energy. Ask students to use the check list to study energy use in their homes and to suggest specific ways in which energy might be conserved in their particular homes.

TaE activity 8-9 can be used to stimulate students to think of actions that will save energy in the home. It asks students to write instructions to an imaginary computer to control energy use in the home.

Buying more energy-efficient appliances saves energy and can save money. Establish that different models can use significantly different amounts of energy. Here are some facts you can use to do this:

In 1977, a well-known American manufacturer sold two similar models of a 17.6 cubic foot refrigerator/freezer. One cost $518 and independent tests predicted it would use 1,188 kWh of electricity a year. The other cost $475; tests predicted it would use 1,716 kWh a year. If electricity costs 8¢ a kWh, what is the difference in the cost of the electricity to run them for a year? (1716 minus 1188 + 528 kWh; 528 time 8¢ = $42.24, or about the difference in their prices!) What will be the difference in the cost of the electricity to run them over a 15-year lifetime? ($633.60, or more than the purchase price of either refrigerator!)

To make this exercise more real, bring to class utility publications, or consumer publications with lists of the energy consumption of different models, or samples of federally-mandated energy labels. (Refrigerators, air conditioners, and automobiles show especially wide ranges of consumption.) Using such sources of information, have students calculate the difference in utility costs between two appliances.

Point out ways shoppers can find out how energy-efficient different models are: information is available from the labels on appliances, at public libraries, from utilities, and in consumer publications.

Extension
Visit an appliance showroom, or have students bring in brochures and advertisements. Discuss the energy conservation claims made in the advertisements. What evidence does each advertiser offer to substantiate its claims?

Buying more durable appliances (or toys) often saves energy. When we discard something, we lose the energy that went into making that object and transporting it to us. (**TaE** 7-65 provides a lesson on this form of energy consumption, which is often called embodied energy.) Repairing broken appliances is a way of saving energy. However, we need to weigh the possibility that a newer model may be so much more energy-efficient than the one we are now using that replacing it will actually save energy. (And of course, a new model may provide other benefits that the old one didn't.)

Recycling materials can save energy. Many communities have facilities for recycling materials like paper, glass, aluminum, and steel. If your community does, ask if any students have participated in a recycling program. Have them describe what they did. How much money did they or their organization earn?

Extension
Visit a recycling operation. What is done to separate various materials, and why?

Another kind of recycling is the re-use of a product. For example, it takes energy to make a paper grocery sack. If we use the bag once more, for example as a lunch bag or to hold garbage, how does that change the energy consumed per use? (Cuts it in half.)

Improving our energy situation requires action. Conclude this brief sequence with an action plan for each student. If you have done **TaE** activity 8-9, point out that many of instructions given to the computer can be done by people without a computer. Ask each student to consider his or her energy uses and write at least one way in which one of these energy uses could be made more efficient. Then plan a strategy for making this improvement.

You may choose to develop these action plans by giving specific home assignments to the students.

Mini-Quiz

1. Give an example of how recycling saves energy.
2. If you were shopping for an air conditioner, how could you tell how energy-efficient a particular model was?
3. Name two ways of saving energy when doing laundry.
4. Name one thing a family can do to save energy just before everyone in the family turns in for the night.
5. Describe a habit that wastes energy.
6. Why does leaving a refrigerator door open waste energy?
7. Why does repairing an appliance instead of buying a new one sometimes save energy?
8. Describe one way of wasting energy when using a clothes dryer.
9. Describe an energy-efficient way of cooking a stew.
10. What is the purpose of the pilot lights on a gas stove? What alternatives to pilot lights are there?

True or False?

1. We use the same amount of energy in baking a potato no matter how we do it.
2. We use the same amount of energy to wash a white shirt no matter how we do it.
3. It takes the same amount of energy to wash a shirt using bleach as it does to wash it without bleach.
4. It is possible to spend more for the energy we buy to operate a machine than we paid for the appliance itself.
5. Putting a lid on a pot of boiling water saves energy, even if you don't turn down the burner.
6. Using separate appliances for cooking is always a waste of energy.
7. Using separate appliances for cooking always saves energy.
8. Doing full loads in dryers and dishwashers saves energy.
9. The amount of energy we buy indirectly when we buy goods and services is very small compared to the amount we buy in the form of electricity, gas, and gasoline.
10. A new appliance will always use less energy than an older model.

Answers

1. There are many possible answers. All involve saving the energy needed to produce the recycled material.
2. It will have a label comparing its energy efficiency with that of similar models.
3. Use cold water instead of hot when possible. Run full loads in washer or dryer. Dry all loads consecutively.
4. Turn down the thermostat in the heating season; pull the drapes or close the shutters; turn off lights; in the cooling season when night time temperatures are low, open the windows.
5. There are many possible answers: e.g., not turning off the lights.
6. Hot air enters, warming the food; the air and food must be chilled again when the door is closed.
7. Repair can increase an appliance's energy-efficiency. It can save energy needed to make and transport a replacement.
8. Don't clean the lint filter. Dry small loads. Let the dryer cool off between loads.
9. In an efficient appliance, such as a crockery cooker, microwave oven, or pressure cooker. In a pot the same size as the burner, with a lid. Inefficient ways include: in the oven, in a pot without a lid.
10. To ignite the gas when a burner is turned on. The gas could be ignited by a match or by electrical devices that make sparks.

True or False?

1. False. For example, on a gas range it takes less energy to bake a potato in a stove-top cooker than it does to bake one in the oven.
2. False. For example, washing in cool water requires less energy than washing in hot. Hanging wash out to dry takes less energy than drying it in a clothes dryer.
3. False. It took energy to make the bleach.
4. True.
5. False. Turning down the burner, or turning it off, is the only way to save energy. The setting of the switch (on an electric range) or the gas valve (on a gas range) is the only thing that affects the rate at which energy is being used. Putting a lid on a pot of boiling water saves energy only because it lets us turn down the heat while still keeping the water boiling, or let's us bring the water to a boil faster.
6. False.
7. False.
8. True.
9. False.
10. False.

Background Information

The amount of energy typically consumed in a year by various home appliances is listed in **TaE** 1-88.

Resources

The annual issues of the **Consumer Buyer's Guide,** published by Consumer Reports, Inc, usually contain energy consumption information on at least one type of appliance. Articles in their monthly magazine often feature energy consumption information.

Public utility commissions, state energy agencies, and public utilities also often issue publications comparing appliances. An example is the booklet **Cold Facts,** supplied free by Southern California Edison.

CONSERVATION

Climate and Comfort

Days Required ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need: **Energy 83** pages 36 and 37.

Climate & Comfort

Student Learning Outcomes

- Students identify controlling heat as the type of energy conservation measure with the greatest potential for saving energy in the home.
- Students describe their climate.
- Students compare the need for heat created by their climate with that created by other climates in the United States.
- Students describe finding the optimum level of insulation as an economic problem in which the need for heat, the cost of energy, and the cost of insulation are balanced.

Suggested Teaching Strategy

Prior to conducting this lesson, determine the price of electricity, fuel oil, and natural gas in your area. A few phone calls to local utilities can obtain this information.

Extension
In many areas, the price of gas or electricity depends on how much you buy. Sometimes the first block you buy is cheaper than the rest, and sometimes—though less often these days—the more you buy the lower the price. Because the last therm of gas or kilowatt-hour of electricity which we purchase is the one we save when we introduce a conservation measure, it is important to use that price—and not the average price—in calculating optimal levels of insulation. (Economists call this the marginal cost.)

People don't like to be cold. Ask students if they can remember a time when they were really cold. Ask them to tell about it. Do people need to keep warm?

Climate creates a need for energy for space heating. Ask students if they think people in Maine use more energy to keep warm than people in Florida do. Why?

Ask students to look at the map at the top of page 36. It is a map about climate—specifically, about how cold the different climates in the United States are. The colder the climate, the more energy people buy to keep warm.

Notice the key at the bottom of the map gives a range of numbers for each color. These numbers are heating degree days. We can use heating degree days to compare the need for heat created by different climates. Ask students to find the number of heating degree days for the area where they live. Are there parts of the country where the need for heat is twice as great as ours? In which states? In which states is their need for heat half as great as ours?

Extension

If you wish to show how heating degree days are calculated, it is easy to do so on the chalkboard. To find the number of heating degree days for one day, we average the maximum and minimum temperature on that day and subtract it from 65. (For example, suppose the highest temperature is 76° and the coldest is 42°. (76 + 42 = 118; 118 divided by 2 is 59). Subtracting 59 from 65 we get 6. So for that day there were 6 heating degree days. To find the total heating degree days for a month or year, we add the numbers for individual days.

Look at our own climate. Have students complete the chart at the bottom of the page. Ask them to add up the number o checks in each horizontal row and enter the number in the last column, the one headed Total. Is our climate such that we can get along without shelter? How many months of the year are too cold for comfort? What do we do then?

This type of heating is called **space heating.**

More money is spent providing heat than on any other use of energy in the typical home. Review the uses of energy in the home. Which use consumes the greatest amount of energy in homes? Ask students to refer to the chart on pages 26 and 27. The students should see that space heating is the largest energy use in residences. (Energy consumption by family automobiles, comparably large, is included under Transportation instead of Residential.)

Insulation is a way of reducing the amount of energy needed to heat a building. It saves money which would otherwise be spent on energy.

To determine how much insulation is needed in a building, three factors must be taken into consideration. The purpose of insulation is to reduce the cost of providing heat (or cooling). But providing insulation costs money, too. To decide how much insulation will save the most money, we need to consider three things.

One factor is the climate. Ask the students who they think spends more money heating their homes, people who live in Minnesota or people who live in Florida? Who could save more money by reducing the amount of energy needed to heat their homes? Conclude that the more severe the climate, the more insulation is economically justified. (With air conditioning, this applies to hot climates also.)

The second is the cost of insulation.

The third factor is the cost of energy. The more energy costs, the more money we can save by insulating. We must take into account not just the price of energy now, but what we expect to pay for it over the lifetime of the house. (An assumption that energy prices will increase 1% per year on the average is built into the point system used.)

With the students, find the predicted optimal level of insulation for your area by using the charts on page 37. These charts will give us "heating points." Inform students that we will use these points when we reach page 40.

Ask the students to find which of the heating zones on the blue map on page 37 they live in. In the chart above it, have students circle the number for their heating zone in the left-hand column headed "Heating Zone."

Give the students the prices of the various sources of energy used in their homes. Ask students to circle the price they pay for energy for heating in the prices along the top of the chart.

Where the row for heating zone meets the column for the price of energy, find the number of heating points.

If many of your students live in homes where air conditioning is used, continue the exercise with the red cooling zone map, following the directions given. Then, using the space at the bottom of the page, add the heating points and the attic cooling points, and also add the heating points to the wall cooling points. If air conditioning is not used in your students' homes, these additional steps are not necessary.

Notes

Mini-Quiz

1. What is the single biggest use of energy in American homes?

2. Is more heating needed in your climate than in most parts of the United States?

3. Is more air conditioning used in your climate than in most parts of the United States?

4. What is the unit called the "heating degree day" used for?

5. Name three factors that should be considered in deciding
6. how much insulation a building should have.
7.

8. Why do homes in Minnesota need more insulation than homes in Hawaii?

9. Under what conditions might a house not need any insulation?

10. Give an example of matching the way a building meets people's need for comfort to the climate in which the building is built.

True or False?

1. The greatest single use of energy in homes is cooking.

2. The more expensive energy becomes, the more insulation it pays to have in a house (other things being equal).

3. Every house in the United States should be very heavily insulated.

4. Two places within 40 miles of each other will certainly have the same climate.

5. The more expensive insulation becomes, the less insulation it pays to put in a house (if nothing else changes).

6. By buying insulation now, a homeowner is avoiding buying energy in the future.

7. Different climates offer different ways to make a building meet people's need for comfort.

8. A house that is energy efficient in one location would be energy efficient no matter where it was built.

9. In a hot climate, adding air conditioning to your home can increase your need for insulation.

10. In every home, more energy is purchased for space heating than for any other purpose.

Answers

1. Space heating
2. (Answer depends on student's location.)
3. (Answer depends on student's location.)
4. To measure the need for heat which the weather (or climate) creates.
5. a) the cost of insulation
6. b) the climate
7. c) the cost of energy
8. People in Minnesota need more heat.
9. The house is in a climate that never gets cold enough to justify heating, or hot enough to justify air conditioning.
10. Many possible answers, including: Using adobe in climates with a large daily temperature swing.

True or False

1. False
2. True
3. False
4. False (for example, the top and bottom of a mountain)
5. True
6. True
7. True
8. False
9. True
10. False

Background Information

Why must we figure out a different number of points for attics and walls for air conditioning?

Most heat loss is through the roof, but summer heat gain is largely through the walls. Compared to a house in a cold climate, a house in a hot climate should have a greater proportion of its insulation in the walls. It is not just a matter of increasing insulation throughout a house in a severe climate.

In the rows for energy prices at the top of page 37, why are there two rows for electricity?

The two rows take into account the very different efficiencies of the two ways of using electricity to heat a house. Electric resistance heating (third row) is 100% efficient (at the point of consumption), but a heat pump (fourth row) typically has a coefficient of performance of 200% or more. It delivers twice as much heat to the house as is supplied to it in the form of electricity; the rest of the heat is taken from the outside air. Thus, the heat pump has half the "fuel" cost of resistance heating.

While there is also a range of efficiencies with which natural gas and fuel oil are used, the options are not so easily recognized by students, the difference is smaller, and the devices with the best efficiencies are not yet widely employed. (For example, some older gas furnaces may be only half as efficient as the new pulse combustion gas furnace, but pulse furnaces are just starting to be installed.) So, to keep things simple, those efficiency differences have not been allowed for.

Where did this point system come from?

The point system used here is based on one devised by economists at the National Bureau of Standards and published in **Making the Most of Your Energy Dollars in**

Home Heating and Cooling, by Madeleine Jacobs and Stephen R. Petersen. (NBS Consumer Information Series 8, 1974). Technical details behind the consumer recommendations can be found in **Retrofitting Existing Housing for Energy Conservation:** An Economic Analysis by Stephen R. Petersen (NBS Building Science Series 64, 1974).* The number of points in the tables have been increased to reflect increases in the cost of insulation since 1974 and to include, primarily for teaching purposes, a much greater range of energy prices. The project thanks Mr. Petersen in particular for his helpful review and suggestions concerning these changes; however, neither he nor the Bureau is responsible for them.

This method is good for teaching purposes, but a homeowner considering purchasing insulation should use a method that takes into account more of the details of his or her house. Useful publications for this purpose include:

In the Bank. . .or Up the Chimney? A Dollars and Cents Guide to Energy-Saving Home Improvements, 2nd edition. U.S. Dept of Housing and Urban Development, August 1977. (USGPO stock number 023-000-00411-9)

Home Energy Savers' Workbook. Federal Energy Administration, 1977. (USGPO stock number 041-018-00116-6)

Consumer Reports. Money-Saving Guide to Energy in the Home. NY: Doubleday and Co., 1978.

Homeowner's Energy Investment Handbook. A Guide to Energy-Efficient Home Improvements That Pay Off, by Michael McClintock. Andover, MA: Brick House Publishing, 1982.

The Energy-Wise Home Buyer. A Guide to Selecting an Energy Efficient Home. U.S. Dept. of Housing and Urban Development and U.S Dept. of Energy. March, 1979. (USGPO stock number 023-000-00518-2)

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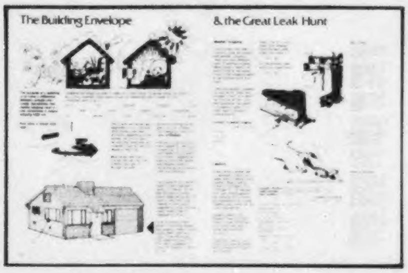
* Since 1974 Mr. Petersen has continued to improve the model—for example, it has been shown that using degree days based on a temperature lower than 65°F leads to more accurate predictions. These refinements are not incorporated because they are not significant for teaching purposes.

The Building Envelope

Days Required ■ ⬓ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need:
Energy 83 pages 38 and 39.
Samples of weather stripping, and a caulking gun, are useful.



The Building Envelope & the Great Leak Hunt

Student Learning Outcomes

- Students can describe the purpose of housing.
- Students describe infiltration as one of the most important ways by which houses lose heat.
- Students locate places in their homes where it would be appropriate to use weather stripping, and evaluate the condition of existing weather stripping.
- Students locate places on their homes where it would be appropriate to use caulking, and evaluate the condition of existing caulking.

Suggested Teaching Strategy

A building is a barrier against the outside world. Read the exercise at the top of page 38. Let students complete it, then discuss it. Which of the items do we always want to keep out? Which sometimes? How do we keep things in or out?

Tell the students that the outer skin of a building is often called its **envelope.** How is it like the envelope of a letter?

There are many ways a house can lose heat. Solicit ideas from students on how heat might escape from a house.

Infiltration is a major cause of heat loss (or gain). Define infiltration as the movement of air in and out of a house.

How can air move through the building envelope? What are some openings we deliberately make in the envelope? What are some accidental openings? Ask students to describe some openings in a building with which they are familiar. Then ask them to read the material on page 38 and do the exercise at the bottom of the page, marking arrows on the drawing according to the directions. The drawing on the next page identifies the cracks in the drawing of the house.

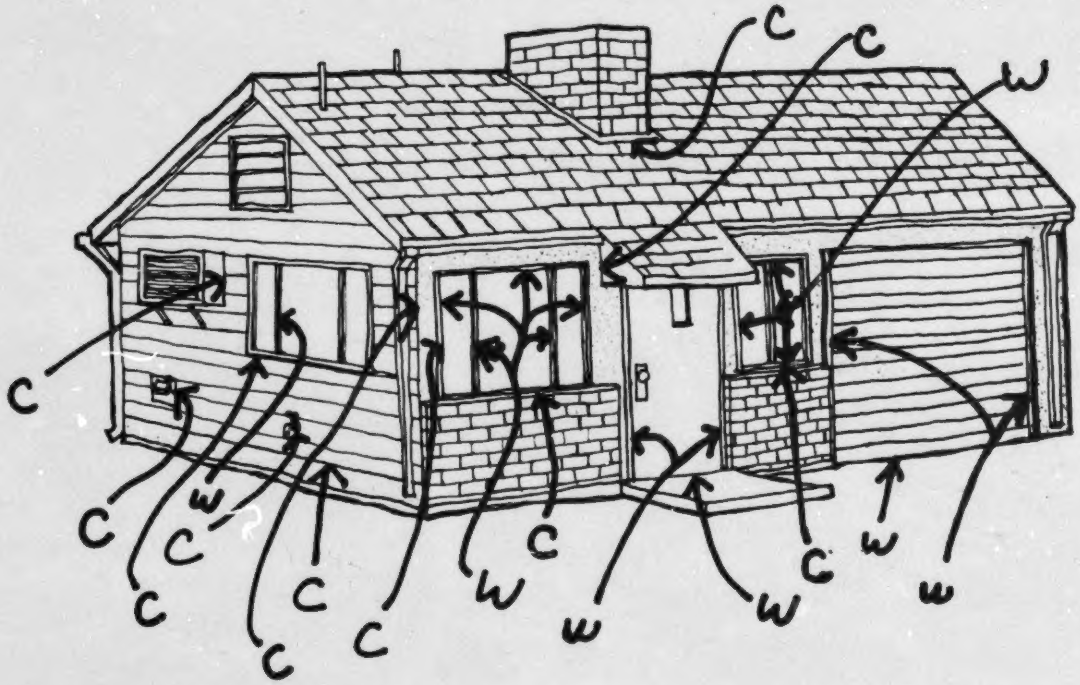
Reveal to the students that W stands for weather stripping, and C for caulking. These are the two chief means for sealing cracks.

Movable joints are sealed with weather stripping. If possible, bring samples of some different kinds of weather stripping to show the class.

Fixed joints are sealed with caulking. If possible, show the students a caulking gun and cartridge.

Ask students to inspect the envelope of their own homes, as suggested on page 38. This activity is appropriate for apartments as well as single-family houses.

A tour of the envelope of the school building to look for caulking and weather stripping can make a good conclusion to this lesson.



Mini-Quiz

1. What is the word for the movement of air in and out of a house?

2. Compare the amount of heat lost in the average house by air leaking in and out of the house with the amount lost by conduction.

3. How do we stop warm air from escaping or cold air from entering the house between the door and the door frame?

4. Name the material used to keep air from leaking through the cracks between windows and their frames.

5. Name the material that is used to stop air leaks and that is squeezed out of a gun.

6. Name one source of indoor air pollution.

7. How can you tell if caulking needs to be replaced?

8. Name two places in a home that require weather stripping.

9. Name three places in a home that require caulking.

10. Describe one way of testing whether weather stripping is in good condition.

True or False?

1. Caulking usually lasts the lifetime of a building.

2. Very little heated air escapes from the average home.

3. If you keep all the windows in a room closed in the average house, you will use up all the oxygen and will suffocate.

4. Applying caulking is a very difficult job that should only by done by a professional.

5. The air inside a home is always less polluted than the air outside.

6. There is no way of keeping cold air from coming in under a door, except by piling newspapers, rugs, or other objects against the door.

7. If there is a large crack where a garage door meets the floor, it should be sealed with caulk.

8. In the average home, stopping infiltration is almost impossible and is not worth the attempt.

9. An open fireplace is always a big help in heating a house.

10. We deliberately make many holes in the building envelope.

Answers

1. Infiltration
2. More heat is lost by infiltration.
3. By installing weather stripping (other methods include installing a vestibule or air lock, or using storm doors)
4. Weather stripping
5. Caulking
6. There are many possible answers, among them cooking, smoking, using household chemicals, and the gases given off by various materials.
7. Caulking needs to be renewed if it is badly cracked, pieces are missing, or if it is missing entirely.
8. Windows, doors, ventilator covers
9. Around the door frame, around the window frame, between the foundation and the sill plate, etc.
10. Close the door or window on a dollar bill and see if you feel resistance when you pull it out.

True or False?

1. False. However, there are a few types of relatively expensive caulking which may last several decades.
2. False
3. False
4. False. It is one of the easiest energy-saving measures to carry out.
5. False
6. False; although piling newspaper is effective and, of course, cheap.
7. False. Many caulks would glue the door shut.
8. False. It is often highly cost-effective.
9. False
10. True; for example doors, windows, vents.

Notes

CONSERVATION

Insulation

Days Required ■ ■ □ □ □ □ □ □ □ □ □ □

For this sequence, your students will need: **Energy 83** pages 40 and 41.

Student Learning Outcomes

- Students list some materials that are good insulators.
- Students describe which part of a home should be insulated first.
- Students examine the use of insulation in their own homes.
- Students describe windows as a major source of lost heat.
- Students name at least ten ways heat flow in the typical home might be improved in order to reduce energy consumption.

Suggested Teaching Strategy

Building materials differ in their resistance to the flow of heat. Discuss the need for slowing the flow of heat. Do all materials conduct heat equally well? Why do some materials feel cold when we touch them (like metal) and others do not (like wood)? Define R-value as a measure of the resistance of a building material to the flow of heat. Ask students which materials on the list on the middle of page 40 are good conductors of heat. Is aluminum a better conductor than brick? What are their R-values? What is the best insulator on the list? Establish that the greater the R-value the greater the resistance to the flow of heat.

It is helpful to have some samples of insulation that students can examine. DO NOT PERMIT students to handle fiberglass, because the fibers irritate skin.

In winter, the greatest heat loss is through the roof or ceiling. Raise the question of what part of a home ought to be insulated first. Does warm air rise or fall? What surface of a house might be warmest?

Heat loss through the ceiling and roof can be slowed by insulation. Help the students look up the recommended level of attic insulation for your locality and energy costs, using the points you found on page 37 and the table on page 40. How many inches of insulation would it take to get this R-value?

R-values for greater thicknesses of material, or for combinations of materials, can be estimated by adding the R-values of the components. The table of R-values on the opposite page can be used to estimate how thick the insulation would have to be to reach a given R-value. For example, if one inch of cellulose has an R-value of 3.5, 3 inches will have an R-value of 10.5 or about 11. (This is not entirely accurate but it gives a rough estimate. Actual R-values stated in manufacturer's literature will be more accurate.)

Encourage students to examine attic or ceiling insulation in their own homes, following the suggestions given.

Heat loss and gain through walls can be slowed by insulation. Using the table, help the students look up the recommended level of wall insulation for your locality and energy costs, using the work you did on page 37 of the student booklet.

Have students determine what thicknesses of various types of insulation would be needed to obtain the R-value suggested.

But most walls are constructed of two-by-fours, which means there is only a space about 3½" deep in which to fit insulation. The drawing on the left shows a cutaway view of such a wall. Have students compare it with the drawing on the right, which is of a type of construction called "superinsulated." Ask a student to explain how extra thicknesses of insulation can fit into such a wall. Which wall would cost more to build? What would you need to know to determine if it was worth the extra expense?

Doors are less resistant to the flow of heat than the walls of a house. Compare the R-values of doors with those of walls.

Windows are a major source of heat loss. Compare the R-value of windows with those of insulated walls. What can we do to improve a windows' resistance to heat loss? Students may suggest drapes or shutters.

Notes

Mini-Quiz

1. What do we call building materials that are used to slow the flow of heat?
2. Name two kinds of building insulation.
3. What is the name of the number used to tell how good an insulating material is at slowing the flow of heat?
4. Name two ways of reducing the amount of heat lost through windows, other than weather stripping.
5. What R-value does the book recommend for attics or ceilings in your area, at present energy prices?
6. What R-value is recommended for walls of air-conditioned homes in your area, at present energy prices?
7. Which has more insulating power, a thick layer of insulation or a thin one? Explain your answer.
8. What is the purpose of building insulation?
9. When you're in a lumber yard, how can you tell how effective an insulation material is?
10. How can walls be built with more than four inches of insulation?

True or False

1. Wood is good insulation for buildings.
2. Wood is a better insulator than metal.
3. If you live in a very hot climate and don't use heating, only air conditioning, your home doesn't need insulation.
4. Every house should have as much insulation as possible.
5. Window glass is good insulation.
6. Brick and stone are good insulators.
7. Every house needs storm windows.
8. If a house in a cold climate is completely uninsulated, the first part that should be insulated is the attic.
9. Insulation stops the flow of heat.
10. Windows and doors are not as well-insulated as walls.

Answers

1. Insulation
2. Fiberglass, cellulose, rock wool, plastic foams, etc.
3. R-value
4. Shutter, insulated shades. . .
5. (Correct answer depends on the student's location.)
6. (Correct answer depends on the student's location.)
7. Thickness doesn't matter; all that matters is the R-value. The thinner layer could have a higher R-value than the thick layer.
8. To slow the flow of heat
9. Read the R-value on the packaging
10. By making two rows of studs instead of one

True or False

1. False
2. True
3. False
4. False
5. False
6. False
7. False. Nothing can stop the flow of heat. Insulation slows the flow of heat.
8. True
9. False
10. True

Background Information

Your students may be impressed by some statistics about the amount of energy saved by some of the methods suggested.

Insulating an attic can save 5% to 30% of the heating and cooling bill.

Wall insulation can save 20% on utility costs.

CONSERVATION

When You're Hot You're Hot. . .

Days Required ■ ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need: **Energy 83** pages 42 and 43.

When you're hot, you're hot

when you're not

Student Learning Outcomes

- Students describe how heat is supplied to their own homes.
- Students describe proper maintenance procedures for one form of home heating.

Suggested Teaching Strategy

Energy savings are reflected in utility bills.

Almost every home has some device to supply heat. Call for a show of hands on the energy sources used to heat students' homes. Ask the students to describe the heating devices that supply warmth to their homes. (It might be good to start this discussion late in the period and carry it over for a homework assignment.) Do these devices do anything besides heat? Some students will know that the furnaces often filter and humidify the air.

Encourage students to inspect their own heating systems.

Furnaces, like many other machines, need an occasional tune-up. Ask students if they have ever observed their home furnaces being tuned up or adjusted. Who does this work? Why might a furnace need tuning up? Stress the importance of keeping the manual that comes with a device like an air conditioner or furnace.

Pipes and ducts carrying hot air, steam, or hot water lose heat along the way. Ask students where pipes run in their homes. Can heat escape from the pipe? What happens to the heat if the pipe is running through a heated part of the house? Is the heat wasted if the pipe runs through an unheated part of the house, such a crawlspace?

Air conditioners require maintenance too. Discuss how keeping filters and coils clean saves energy.

Windows can contribute to heat loss or gain in a home. With the students, determine which way is north in your community, so that students can relate the street grid to the cardinal directions. If your classroom has windows, discuss which direction they face. Does sunlight come through them at any time of day? Suggest that students carry out the survey on page 43.

Mini-Quiz

1. How can you tell whether a furnace filter needs to be replaced?
2. Why should the coils of an air conditioner be kept clean?
3. If a furnace will run, can there be need for a repairperson to visit it? Why?
4. Why, in order to save energy, do we raise the thermostat setting on an air conditioner, but lower it on a furnace?
5. Name three ways to shade a window.
6. Why should an air conditioner be shaded, if possible?
7. What is the name of the part of a heating system that controls the temperature?
8. Which windows in a house can help to heat it?
9. What energy source provides the heat to your home? If you have air conditioning, what energy source drives it?
10. What is the name of the part of an air conditioner where heat is exhausted to the outside air?

True or False?

1. Most heating systems that use moving air filter dust out of the air.
2. In most houses, energy is saved if all rooms are heated to the same temperature.
3. Planting trees on the south side of a house can lower the cost of air conditioning the house.
4. Turning the furnace thermostat down at night does not save energy, because in the morning the home will just have to be warmed up again.
5. Even if you lower your energy consumption, your utility bills could still keep rising.
6. A house should have most of its windows on the north, since north-facing windows let in even, pleasing skylight.
7. The less time it takes a furnace to warm up a cold house, the better the furnace.
8. Clock thermostats can turn down the temperature setting at night, but they can't turn it back up in the morning.
9. The manual that comes with a furnace or air conditioner is mostly advertising that can be thrown away as soon as the machine is installed correctly.
10. In the United States, direct sunlight never comes through windows that face north.

Answers

1. It blocks light. Another method, not mentioned in the text, is to install inexpensive whistles in the filter that sound when the filter is clogged.
2. Dirt slows the flow of heat out of the coils, and so increases the energy consumption of the air conditioner.
3. Yes. The burners of gas and oil furnaces need occasional adjustments.
4. The higher the thermostat setting, the less time the air conditioner will be on. The lower the setting, the less time the furnace will be on.
5. Trees, awnings, building overhang, trellises, and many other possibilities.
6. The cooler the coils, the easier it is for the air conditioner to get rid of heat.
7. Thermostat.
8. Those that face south, south-east, and south-west.
9. Depends on the student's home.
10. The coils.

True or False?

1. True
2. False
3. True, in the United States
4. False
5. True
6. False; even though it is true that the evenness of north light makes it an ideal light for some purposes, such as lighting an artist's studio.
7. False. For example, imagine a furnace big enough to warm up a house in one minute. Energy would be wasted because it would have to come on and off very often. Each time the furnace itself would have to be warmed up, as well as all the ductwork, and both the furnace and ducts would be very large. A comparable but smaller furnace running more of the time longer would send less energy up the chimney and into unheated spaces.
8. False. Some can make six different temperature settings each day.
9. False
10. True

Notes

Getting into Hot Water

Days Required ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need:
Energy 83 page 44.

Getting Into Hot Water

Student Learning Outcomes

- Students identify the energy source used to provide hot water in their homes.
- Students describe proper maintenance of a hot water heater.
- Students describe three ways of conserving hot water.

Suggested Teaching Strategy

Water heating is a significant use of energy. Ask students to answer the first column of questions on page 44. Together, examine the graph on page 27. Is water heating a major use of energy in homes?

Call for a show of hands on which energy source is used to provide hot water in the students' homes. Which energy source appears to be most used in your area to provide hot water?

Hot water has many important uses. Elicit some uses for hot water and list them on the chalkboard. How would our lives be different without hot water? Would a lack of hot water create any really serious problems? How does hot water help to prevent disease?

Some means of heating water use less energy than others. How can we improve the efficiency of water heaters? Students may suggest adding more insulation. Some students' parents may have added an additional blanket of insulation to their water heaters. Manufacturers can also add more insulation. And there are other methods. For example, even while the heater is not firing, air can circulate through the flue, cooling the water in the tank. An automatic damper can be added to prevent this.

Extension
Compare two water heaters in a store or from advertising literature. Do they differ greatly in the amount of energy they use.

Many water heaters benefit from regular maintenance. Review with students how the sediment in the bottom of a gas- or oil-fired water heater acts as an insulator, reducing efficiency. Encourage those with gas or oil fired heaters to try the draining activity described in the booklet at home, with their parents' help. (Electric heaters do not need to be drained, as the heating element is not at the bottom of the tank where it could be insulated by sediment.

Some ways of using hot water use less energy than others. Ask students what they use hot water for. How could we do these things using the least possible hot water? For example, in the bathroom, a shower head with a fine spray will do as good a job of rinsing using less water than a regular shower head, or a tub bath. In the laundry, many kinds of soiled clothes can be washed in warm water, or rinsed in cold water.

Extension
Encourage students to devise an experiment to compare the cleaning power of hot and cold water in doing their families' laundry.

Energy is needed to supply all water, not just hot water. What are some of the things that need to be done to get water to our homes? Do these tasks require energy?

Extension
If there is a leaky faucet at home, use a cup to catch the drip and calculate how many gallons of water are being lost in a day. (One gallon equals 16 cups.) A drop of water leaking each second may cost as much as 60 gallons of hot or cold water a day.

Notes

Mini-Quiz

1. Why is it more important to insulate hot water pipes that run through unheated areas than those that run through heated areas?

2. Where does heating water rank among energy uses in homes in the United States?

3. What is the purpose of the thermostat on a water heater?

4. How does having a dishwasher affect the temperature setting of your water heater?

5. Why does an occasional draining of oil and gas water heaters save energy?

6. Describe one way of conserving energy when doing laundry.

7. What is the name of the pipe that carries the gases from burning oil or gas in a water heater to the chimney?

8. How can hot water be conserved when people wash themselves?

9. Two families live next door to each other in identical houses. One family is an elderly retired couple. The other family is a young couple with four children less than ten years old. In the two families, will the amount of energy used for space heating be the same percentage of the amount of energy used for water heating? Explain your answer.

10. How can insulation be added to a water heater?

True or False?

1. All clothing should be washed in hot water.

2. No clothing needs to be washed in hot water.

3. Showers usually use more hot water than tub baths.

4. About half of all the energy used in homes is used to heat water.

5. A thousand gallons of water could go through a dripping faucet in a year.

6. Heating hot water is the single largest use of energy in some families.

7. The lower the thermostat setting on your water heater, the less energy you will use for water heating.

8. Draining sediment from electric water heaters will not save energy.

9. All shower heads use more or less the same amount of water.

10. Leaky faucets waste water, not energy.

Answers

1. Heat lost from a pipe in an insulated area helps to warm the house; heat lost in an uninsulated area is entirely wasted. Also, a hot pipe in a cold environment will lose heat more rapidly than a hot pipe in a warm environment.
2. Second.
3. To determine to what temperature the water will be heated.
4. Older dishwashers that do not have built-in water heaters need hot water at 140°F.
5. It removes sediment at the bottom of the tank that acts as an insulator.
6. Use cool water rinse. Use warm water wash when appropriate. Dry full loads, etc.
7. The flue.
8. Shower instead of bath.
9. No. The young family will use much more energy for water heating than the retired couple, because they will have much more laundry to do and more baths to be taken. (Probably, they will use more energy for water heating than they do for space heating, and the older couple will use more energy for space heating than they do for water heating.)
10. You can buy fiberglass blankets that can be taped around the water heater, like a jacket.

True or False?

1. False
2. False (E.g., baby's diapers.)
3. False
4. False
5. True
6. True
7. True
8. True
9. False
10. False

Answers to the Questions on Page 45

True or False?

False. For example, insulating a house in the Florida Keys to R-66 would be a waste of resources
True. A study in Texas found that 20% of the air leakage in a group of homes was through the wall outlets.
False. They can save money by raising the thermostat setting. True. Much of the conductive loss is through the windows.
False. It also depends on how the cook does things; for example, how long he or she stands in front of an open refrigerator.
False. Aluminum itself is an excellent conductor, though siding is often combined with a layer of insulation.
True. Through the door and out the outside vent.
True.

Refrigerators
door seal = INFILTRATION
cleaning coils = INSULATION

Both types of insulation have an R-value of 20, so there is no difference in their insulating effect.

Day A has 5 heating degree days; Day B, 10. So we would expect more heat to be required on Day B.

Between a window frame and the siding = caulking

Between a door and door frame = weather stripping

A clogged filter will be opaque.

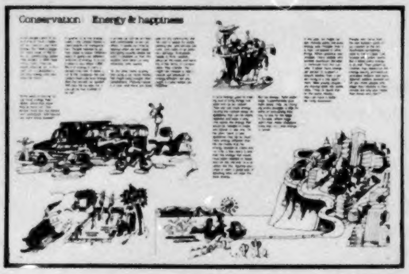
Notes

CONSERVATION

Energy and Happiness

Days Required ■ ■ ■ □ □ □ □ □ □ □ □ □

For this sequence, your students will need:
Energy 83 pages 46 and 47.
TaE activities 8-3, 8-4.



Conservation Energy & happiness

Student Learning Outcomes

- Students will be able to give examples of different lifestyles and relate elements of these lifestyles to different levels of energy use.
- Students will be able to present arguments for and against the idea that there is a direct, positive relationship between the quality of life and the amount of energy used.

Suggested Teaching Strategy

"Some people seem to believe that to have a better life, you have to use more energy." This first sentence on page 46 of **Energy 83** presents the hypothesis to be examined as a number of topics are developed. To begin, ask students to read pages 46 and 47. Then ask them if they believe the first sentence is true. If so, what might lead people to such a belief? What examples could be given as proof that the idea is true?

Now ask students to think about the statement in terms of the entire society and its needs for energy. A discussion pattern for this examination forms **TaE** activity 8-3, which begins with a conclusion by Tolstoy.

Some ways of having fun seem to use more energy than others. With your students, produce a chart on the chalkboard that compares the energy-intensiveness of different forms of recreation with the class's opinion about how much fun can be derived from each activity.

Make a chart on the chalkboard with one wide column on the left and two narrow columns on the right. Ask students to name different forms of recreation. List these activities in the wide column. Use one of the narrow columns to rate these activities from 1 to 5 according to how much fun the class thinks might be derived from the activity. In the third column, rate the activities from A to E according to the class' estimate of amount of energy used in each activity.

Now compare the lists in the two narrow columns. Are most 5's also E's? Is it possible to have a good time if one is restricted to only A-level energy-using activities?

Do the benefits of different forms of transportation correspond to their energy cost per person-mile? A quarter of all the energy used in the United States is used for transportation. Review the bus/private car comparison on page 46. Then discuss what forms of transportation are available in your community. What transportation needs do the people have? What energy and convenience trade-offs are involved in each transportation alternative? Are there unexploited modes of transportation? For example, how feasible is it to travel by bicycle in this community?

Much of our energy goes for making and transporting things that soon end up as rubbish. Ask your students to think about the things they throw away in a day or a week. Be sure to include the things others throw away on their behalf (such as mother discarding uneaten food, wrappings. . .). See if these discards can be categorized. For example, how much that we throw away is wrapping? How much is intended to have a short useful life? How much is being discarded because it has been misused? How much because the items are just old? For each category, see if you can find more economical alternatives (e.g. packing food in a reusable bag rather than in a new bag provided by the grocery store).

As a homework assignment, students might be asked to discuss with their parents the last time an appliance or car was replaced. What conditions led the parent to decide to replace the old one? What considerations led to the choice of the model purchased? What role, if any, did energy use have in the decision?

In the recent past, we sometimes made the decisions we did partly because energy was cheaper than it is today. Ask your students to think about some things in your own community. Are there examples of buildings or modes of transportation that were made when energy was less expensive but are still in use (e.g., very large, uneconomical cars; ornate but hard to heat buildings. . .)? Are there replacements that are more energy efficient? How might increasing energy costs affect buildings, parks, transportation, etc., in your community?

Some things that seem to us to be "free" are not free when one considers the energy involved. Ask your students to name "free" things in your community. The list may include not only paper bags, but services like schooling and the use of the public library or the roads. Try to determine how each of these items is paid for and what is involved in getting the material or service to the point of use. Discuss the energy implications of each "free" item.

While energy is involved in almost anything we do, our quality of life may not depend on using energy at the present rate—only on using energy most efficiently. Ask your students to suggest ways in which energy economies can be made in your community without seriously altering the desirable qualities of the community.

TaE activity 8-4 can be an excellent way to complete this sequence. It is an activity that involves students in finding the best ways to lower energy bills while maintaining their desired lifestyles.

Mini-Quiz

1. Name a form of recreation that you enjoy that uses a lot of energy.

2. Name a form of recreation that you enjoy that uses very little energy.

3. How much more energy is used in moving one person by automobile rather than by bus?

4. What could be one reason for choosing an auto rather than a bus to ride?

5. Name two benefits and two costs of owning a car.

6. You own an old appliance that has stopped working. You can repair it or you can buy a new model. Name one of the things you would consider in deciding what to do.

7. Name one "free" product or service in your community. Then tell how the cost of that product or service is passed on to you.

8.
9.
10. } Name the three things that you think would contribute most to your having a happy, productive life as an adult. How is energy required to provide each of these things? For each of these things, will using more energy make you even happier?

True or False?

1. Most forms of recreation use about the same amount of energy.

2. The energy savings from bus riding always outweigh the problems incurred in riding the bus.

3. If what we are buying will shortly end up in the rubbish pile, we shouldn't buy it.

4. People tend to use more of anything they don't have to pay for.

5. In trying to make a product more energy-efficient, manufacturers always end up making a product that isn't as good as the old one was.

6. In trying to make a product more energy-efficient, manufacturers sometimes end up trading energy-efficiency for some desirable feature of the old model.

7. It is unhealthful to use power-driven machinery to do things we could do with our own muscles.

8. How much energy we use depends a great deal on the price of that energy.

9. Money can't buy happiness.

10. No change of any sort is possible without using energy.

Answers

1. Cruising, water skiing, racing cars or power boats. . .
2. Walking, jogging, tennis, swimming, painting,. . .
3. About two times as much energy.
4. Convenience, comfort. . .
5. Comfort and time savings might be benefits; cost of buying and operating and problems of parking might be costs.
6. Cost of repair and purchase, savings in energy.
7. Paper bags in grocery stores make the groceries cost more; use of a free library is paid for in taxes.
8. Answers depend entirely on the student. They might include:
9. a good job
10. a good marriage
    a home of my own
    the strength to fulfill the tenets of my religion
    and so on. The reasonableness of the student's thoughts on how these items depend on energy use can only be examined item by item.

True or False?

1. False
2. False
3. False (For example, a Band-Aid)
4. True
5. False
6. True
7. False
8. True
9. This is a touchstone, not a question.
10. True

Background Information

To many students, rising energy costs and the prospect of lower personal consumption imply a future lifestyle that may be far less satisfying than the one they now enjoy, or that their parents enjoyed. To what extent does well-being, or the difficult to define "quality of life," depend on energy consumption? Is it true that the more energy you consume, the happier you will be?

Energy is necessary for every good and service we use, including food. In general, the lower a nation's per capita energy consumption, the lower its per capita Gross National Product and the lower its material standard of living. Historically, over the last thousand years, the standard of living and energy consumption appear to have increased very roughly in parallel.

On the other hand, countries with the same per capita GNP may use significantly different amounts of energy per capita. The Swedes, for example, use less energy per capita than we do. In our own country, for the last ten years, the ratio of energy consumption to GNP has been declining. Between 1973 and 1979, industrial energy consumption rose by 3.2% and output rose by 17%. Perhaps most telling, in the consumer or industrial area, is that it is easy to find examples of ways to do things more efficiently instead of doing without.

In considering the question of energy and quality of life, students can benefit from looking at their own immediate situation and at how they might improve the efficiency of their own energy use.

CONSERVATION

Energy Saving at Work

Days Required ■ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

For this sequence, your students will need: **Energy 83,** page 48.

Student Learning Outcomes

- Students name an industry and identify ways in which that industry has conserved energy.
- Students identify the rising costs of energy as one incentive for industry to conserve energy.
- Students include finding ways to use waste heat as a major energy conservation method in industry.
- Students begin to think of ways that energy conservation methods developed in industry can be applied at home.

Suggested Teaching Strategy

Driven by the rising cost of energy, businesses and industries are finding new ways to make the best uses of energy resources. Ask your students to read page 48 in **Energy 83.** This reading gives six examples to show how business are changing to conserve energy. Make a list of these six ways. Ask your students if they can think of other examples of ways to save energy. Think about the industries in your area. Have some of these industries conserved energy by changing the kinds of raw materials they use? Have any conserved energy by using waste heat? By adopting new processes or manufacturing techniques?

Thinking about local industries, which of them would be most affected by energy turn-offs? Which industries might easily conserve by closing at times of peak energy use in the community? Are there examples in your community of industries that have drastically changed their energy habits recently? If so, why?

Are there new factories being built in the area? If so, are they being designed to use energy in different ways from those used in the older factories? Do the new ways include energy-saving techniques?

Some of the new energy habits and patterns being developed in industry can be applied in the home. Discuss how this might be done. What are some sources of waste heat in the home? How might this waste heat be utilized? (For example, not draining a bathtub full of hot water until it has reached room temperature.) Are there changes you could make in lighting your home that would conserve energy?

Suppose that you had to give up the use of some appliance in your home whenever energy was in short supply. Which appliance would you feel must be kept on?

Which wouldn't matter? For which would the turn-off be a minor inconvenience?

Whether in industry or at home, each attempt to conserve energy must take into consideration the whole process of securing and using the energy. A few years ago there was a brief controversy over which used more energy, permanent-press Dacron and cotton shirts or all-cotton shirts. Think of the entire system that the use of either type of shirt implies. What energy uses would be necessary to make and use either of these products?

Notes

Mini-Quiz

1. What event marked the beginning of the push by American businesses to use less energy than in the past?
2. Firm A and Firm B make similar products and sell their products for similar prices. Firm A uses twice as much energy as firm B per product. Which firm would you rather work for? Why?
3. Give an example of a business or industry that would be more seriously hampered than most if it were required to shut down during times of peak energy use.
4. In what form is most waste energy in industry given off?
5. Why might a business decide to burn its lights all night?
6. Name one reason why an industry might decide not to make a change that would save energy.
7. Name a product that does not require energy to produce.
8. Give an example of something an industry can do to save energy without spending very much money to get started.
9. Give an example of something an industry can do to save energy that does require investing a great deal of money in making the change.
10. Why did industries in some other countries invest in energy-saving measures before American industries did?

True or False

1. Substituting plastic for metal always saves energy.
2. A major factor in deciding what energy changes to make is the cost of making the change.
3. Energy conservation methods that cost a lot to start up cannot be effective.
4. Some industries use much more energy per dollar of goods sold than other industries do.
5. Saving energy in industry always means fewer jobs for workers.
6. Industries that use a lot of energy are bound to go out of business.
7. Industry could get along for a little while without energy if it had to.
8. Sometimes you can use more workers instead of fuel.
9. An energy-efficient industry will make an energy-efficient product.
10. Business and industry use the same energy sources as consumers.

Answers

1. The oil embargo of 1973.
2. A good case can be made for either A or B; the important point being the reason given. Firm B if the student argues that the costs at firm B are less and so his or her job would be more secure because of better profit margins or a lower sales price. Firm A if one argues that A company has potential for energy conservation that would allow it to reduce the cost of the product it sold, since its price is already competitive with Firm B.
3. Hospitals, film processing, steel-making, any process industry in which material in process is destroyed by a power outage. . .
4. Thermal energy.
5. The lights might be part of the heating system for the building.
6. The cost of making the changes might be greater than the price of the energy saved.
7. No such product exists.
8. Turning out the lights at night, providing preferential parking for carpools, etc.
9. Building a new factory, installing a new process, etc.
10. Energy was more expensive in those countries than it was in the United States.

True or False?

1. False
2. True
3. False
4. True
5. False
6. False
7. False
8. True
9. False
10. True

Background Information

This topic becomes much more real if you can relate it to local industry. It is sometimes possible to persuade someone from a factory to speak to the class. Many industries have engineers who are specifically responsible for their plant's energy consumption.

Another alternative is to relate this topic to the school plant. The same basic principles of conservation apply.

Resources

Check with your local utility company. It may have information about energy conservation for both industries and homes.

Your local community college may have a speaker's bureau that would supply you with a guest speaker familiar with energy-conservation methods.

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